

SET NO. _____

PROJECT MANUAL FOR THE CONSTRUCTION OF

**Maryland State Police
Tactical Administration Services Building**

AT THE

**Waterloo Barracks, 7777 Washington Boulevard
Jessup, Howard County, Maryland**

FOR THE

Department of State Police

DGS PROJECT NO. PA-745-210-001

PROJECT CLASSIFICATION: G

SEPTEMBER 05, 2023

STATE OF MARYLAND

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TABLE OF CONTENTS

DIVISION 00 – PROCUREMENT AND CONTRACT REQUIREMENTS

003132 Geotechnical Data

DIVISION 01 – GENERAL REQUIREMENTS

011000 Summary
012100 Allowance
012200 Unit Prices
012300 Alternates
012500 Substitution Procedures
012600 Contract Modification Procedures
012900 Payment Procedures
013100 Project Management and Coordination
013200 Construction Progress Documentation
013233 Photographic Documentation
013300 Submittal Procedures
014000 Quality Requirements
014200 References
015000 Temporary Facilities and Controls
015010 Temporary Facilities and Controls – State Field Office for Capital
Improvement Projects
015639 Temporary Tree and Plant Protection
016000 Product Requirements
017300 Execution
017419 Construction Waste Management and Disposal
017700 Closeout Procedures
017823 Operation and Maintenance Data
017839 Project Record Documents
018113 Sustainable Design Requirements
018113.01 Indoor Air Quality

DIVISION 02 – EXISTING CONDITIONS

Not Used

DIVISION 03 – CONCRETE

032000 Concrete Reinforcing
033000 Cast-In-Place Concrete

DIVISION 04 – MASONRY

042200 Concrete Unit Masonry
042613 Masonry Veneer
047200 Cast Stone Masonry

DIVISION 05 – METALS

051200	Structural Steel Framing
052100	Steel Joist Framing
053100	Steel Decking
054000	Cold Formed Metal Framing
055000	Metal Fabrications
055113	Metal Pan Stairs
055213	Pipe and Tube Railings

DIVISION 06 – WOOD, PLASTICS, AND COMPOSITES

061000	Rough Carpentry
062023	Interior Finish Carpentry
066400	Plastic Paneling

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

071326	Self-Adhering Sheet Waterproofing
071416	Cold Fluid-Applied Waterproofing
072100	Thermal Insulation
072119	Foamed-In-Place Insulation
072726	Fluid-Applied Membrane Air Barriers
074213.23	Metal Composite Material Wall Panels
074293	Soffit Panels
075423	Thermoplastic-Polyolefin (TPO) Roofing
077100	Roof Specialties
077129	Manufactured Roof Expansion Joints
077200	Roof Accessories
078413	Penetration Firestopping
078443	Joint Firestopping
079200	Joint Sealants
079219	Acoustical Joint Sealants

DIVISION 08 – OPENINGS

081113	Hollow Metal Doors and Frames
081416	Flush Wood Doors
083113	Access Doors and Frames
083213	Sliding Aluminum Framed Glass Doors
084113	Aluminum-Framed Entrances and Storefronts
087111	Door Hardware
087113	Power Door Operators
088000	Glazing
088813	Fire-Rated Glazing
088853	Security Glazing

DIVISION 09 – FINISHES

090561.13	Moisture Vapor Emission Control
092116.23	Gypsum Board Shaft Wall Assemblies
092216	Non-Structural Metal Framing
092900	Gypsum Board
093013	Ceramic Tiling
095113	Acoustical Panel Ceilings
096253	Synthetic Turf Flooring
096500	Resilient Flooring
096723	Resinous Flooring
096813	Carpet Tile
096933	Low-Profile Fixed Height Access Flooring
097200	Wall Coverings
098313	Acoustic Wall Coating
098433	Sound-Diffusing Wall Units
099000	Painting
099611	High-Performance Coatings

DIVISION 10 – SPECIALTIES

101100	Visual Display Units
101416	Plaques
101419	Dimensional Letter Signage
101423.16	Room-Identification Panel Signage
102113.19	Plastic Toilet Compartments
102600	Wall and Door Protection
102800	Toilet and Bath Accessories
104413	Fire Protection Cabinets
104416	Fire Extinguishers
105123	Plastic-Laminate Clad Lockers
109900	Miscellaneous Specialties

DIVISION 11 – EQUIPMENT

111136	Vehicle Charging Equipment
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DIVISION 12 – FURNISHINGS

122413	Roller Window Shades
123216	Manufactured Plastic-Laminate-Clad Casework
123553.13	Metal Laboratory Casework
123619	Wood Countertops
123661.16	Solid Surfacing Countertops
123661.19	Quartz Agglomerate Countertops

DIVISION 13 – SPECIAL CONSTRUCTION

131900 Kennel Equipment
134717 Bullet Resistant Storefront

DIVISION 14 – CONVEYING EQUIPMENT

142400 Hydraulic Elevators

DIVISION 21 – FIRE PROTECTION

210517 Sleeves and Sleeve Seals for Fire Suppression Piping
210518 Escutcheons for Fire Suppression Piping
210523 General Duty Valves for Fire Protection Piping
210548 Vibration Controls for Fire Suppression and Equipment
210553 Identification for Fire Suppression Piping and Equipment
211119 Fire Department Connections
211313 Wet Pipe Sprinkler Systems

DIVISION 22 – PLUMBING

220517 Sleeves and Sleeve Seals or Plumbing Piping
220518 Escutcheons for Plumbing Piping
220523 Valves for Plumbing Piping
220529 Hangers and Supports for Plumbing Piping and Equipment
220548 Vibration Controls for Plumbing Piping and Equipment
220553 Identification for Plumbing Piping and Equipment
220716 Plumbing Equipment Insulation
221116 Domestic Water Piping
221119 Domestic Water Piping Specialties
221123 Facility Natural Gas Piping
221316 Sanitary Waste and Vent Piping
221319 Sanitary Drains
221413 Facility Storm Drainage Piping
221423 Storm Drainage Piping Specialties
221429 Sump Pumps
223400 Fuel Fired Domestic Water Heaters
224000 Plumbing Fixtures

DIVISION 23 – HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

230010 Basic Mechanical Requirements
230030 Electrical Requirements for Mechanical Equipment
230050 Basic Mechanical Materials and Methods
230055 Basic Piping Materials and Methods
230100 Valves

Maryland State Police
Tactical Administration Center
PA-745-210-001

230190	Mechanical Identification
230510	Hydronic Piping
230519	Meters and Gauges for HVAC Piping
230529	Supports and Anchors
230540	HVAC Pumps
230548	Vibration Controls
230593	Testing, Adjusting and Balancing
230783	Mini Split System
230855	UVC Appliance for Air Stream Disinfection
230923	Direct Digital Controls
232300	Refrigerant Piping
233113	Metal Ductwork
233120	Acoustic Roof Curb
233300	Ductwork Accessories
233319	Duct Silencers
235190	Mechanical Identification
235216	Condensing Boilers
235250	Mechanical Insulation
235932	Air Outlets and Inlets
237200	Energy Recovery Units
238126	Variable Refrigerant Volume Air Conditioning
238239	Unit Heaters
238316	Radiant Heating Hydronic Piping

DIVISION 26 – ELECTRICAL

260010	Basic Electrical Requirements
260050	Basic Electrical Materials and Methods
260110	Raceways
260119	Underground Ducts and Manholes
260120	Low Voltage Wires and Cables (100-600 Volts)
260135	Boxes and Cabinets
260143	Wiring Devices
260170	Circuit and Motor Disconnects
260190	Supporting Devices
260195	Electrical Identification
260420	Service Entrance
260425	Switchboards
260470	Panelboards
260475	Protective Devices
260477	Fuses
260503	Poles and Standards
260512	Exterior Lighting Fixtures
260515	Interior Lighting Fixtures
260526	Grounding
260535	Emergency Lighting
260572	Overcurrent Protective Device Short-Circuit Study

Maryland State Police
Tactical Administration Center
PA-745-210-001

260573 Overcurrent Protective Device Coordination Study
260574 Arc-Flash Hazard Analysis
260671 Surge Protection Devices (SPD)
260800 Commissioning of Electrical Systems
260924 Lighting Occupancy Sensors
263213 Power Generator Sets
263600 Transfer Switches
264113 Lightning Protection

DIVISION 27 – COMMUNICATIONS

270000 General Communications Provisions
270100 Common Work Results for Communications
270200 Communications Equipment
270536 Cable Trays
274100 Audiovisual System
275000 Data, Voice and Video Systems
275200 Grounding and Bonding
275800 Conduit and Backboxes
276000 Telephone and CATV Utility Service Provisions

DIVISION 28 – ELECTRICAL SAFETY AND SECURITY

280500 Common Work
282300 Security Camera
283111 Fire Alarm System
284000 Access Control and Alarm
285200 Grounding and Bonding
285800 Conduit and Backboxes

DIVISION 31 – EARTHWORK

311000 Site Clearing
312000 Earth Moving

DIVISION 32 – Exterior Improvements

321216 Asphalt Paving
321313 Concrete Paving
321373 Concrete Paving Joint Sealants
321723 Pavement Markings
323113 Chain Link Fences and Gates
329113 Soil Preparation
329200 Turf and Grasses
329200 Plants

Maryland State Police
Tactical Administration Center
PA-745-210-001

DIVISION 33 – Utilities

331415	Site Water Distribution Piping
334199	Stormwater Management
334200	Stormwater Conveyance

APPENDIX A – GEOTECH REPORT

End Table of Contents

DOCUMENT 003132 - GEOTECHNICAL DATA

1.1 GEOTECHNICAL DATA

- A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information, but are not a warranty of existing conditions. This Document and its attachments are not part of the Contract Documents.
- B. A geotechnical investigation report for Project, prepared by Specialized Engineering, in Report No. 218680 dated April 21, 2022 and is appended to this Document.

END OF DOCUMENT 003132

**Report of Subsurface Exploration and
Geotechnical Evaluation
MSP TACTICAL SERVICES OPERATIONS AND COMMAND BUILDING
Washington Boulevard – Jessup, Maryland
Specialized Engineering Project No. 218680**

Prepared for:

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April 21, 2022





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Reference: **Report of Subsurface Exploration and Geotechnical Evaluation
MSP TACTICAL SERVICES OPERATIONS AND COMMAND BUILDING**
Maryland State Police (MSP) Waterloo Compound
Washington Boulevard
Jessup, Maryland
Specialized Engineering Project No. 218680



Dear Mr. Asbury:

Specialized Engineering is pleased to submit our report concerning subsurface exploration and geotechnical evaluation for the proposed MSP Tactical Services Operations and Command Building project, located in Jessup, Maryland.

The report explains the exploration procedures, describes the general site and subsurface conditions, and presents evaluations and recommendations relevant to geotechnical considerations for the project. If project characteristics presented in this report are changed, **Specialized Engineering** should be notified so that the evaluations and recommendations presented can be reviewed and revised, as necessary.

If you have any questions concerning this report or require additional assistance on the project, please do not hesitate to contact us.

Respectfully submitted,
Specialized Engineering


Jeremiah Cook, P.E.
Geotechnical Engineer

04/21/2022



Ira L. Helms, P.G., P.E.
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TABLE OF CONTENTS

1.0	EXECUTIVE SUMMARY	1
2.0	PROJECT INFORMATION.....	3
2.1	Proposal and Project Authorization	3
2.2	Project Description	3
2.3	Purpose and Scope of Services	4
2.4	Subsurface Exploration	5
2.5	Laboratory Testing	6
2.6	Infiltration Testing.....	6
3.0	SITE AND SUBSURFACE CONDITIONS	7
3.1	Site Location and Description.....	7
3.2	Area Geology	8
3.3	Subsoil Conditions	10
3.4	Groundwater Conditions	11
4.0	GEOTECHNICAL EVALUATION	12
5.0	RECOMMENDATIONS	14
5.1	Site Preparation & Earthwork	14
5.2	Foundations	16
5.3	Slabs-On-Grade	18
5.4	Seismic Site Classification	19
5.5	Pavement Design	19
5.6	Stormwater Facilities.....	21
6.0	CONSTRUCTION CONSIDERATIONS	22
6.1	Construction Quality Control	22
6.2	Responsibility of the Developer.....	22
7.0	REPORT LIMITATIONS	24

APPENDICES

Boring Location Plan	Appendix A
Boring Logs	Appendix B
Laboratory Test Results	Appendix C

1.0 EXECUTIVE SUMMARY

This Executive Summary is provided for the convenience of the reader interested in having a basic understanding of the geotechnical investigation performed for a new MSP Tactical Services Operations and Command Building and Explosives Containment Yard (ECY) project located at the Washington Boulevard Waterloo Compound in Jessup, Maryland. The full text of this report should be studied and understood by Owners, Developers and Design Professionals before preparing design and construction documents for the project. In addition, there are important limitations regarding this report that should be fully understood. The reader should contact Specialized Engineering (SE) with any questions regarding this report.

Shallow foundations (continuous and spread footings) are considered adequate for the support of the proposed building. The footings should be supported on the undisturbed, suitable-bearing natural soils, except moderately to highly plastic clays and elastic silts ($LL > 40$ and $PI > 20$) wherever encountered, or on controlled structural fill placed on suitable natural soils.

Additionally, if the column and wall loadings of the proposed structure are considerably higher than values assumed in this study, then SE should be afforded the opportunity to revise the recommendations presented within this report.

A review of the site plans, in conjunction with the field exploration, show that the building pad site is graded relatively flat. Standing water in the building area was observed to be present after rain events. Additionally, the boring log data shows that a layer of relatively soft and loose material exists at the surface and extends to depths of 2 to 3 feet below existing grades. SE believes that the flat site grades have allowed water infiltration over a long period of time potentially causing the surficial soils to become unsuitable to support loads. Site preparation and proof rolls will be critical in determining the possible extent to which these soils may exist, and whether or not the new fill can be placed directly on top of the existing soils or if removal of the soft/loose soils will be necessary.

While not encountered within the extents of our investigation, some highly-plastic, fat clay and/or elastic silt soils could be present at the site and should not be used as engineered fill. Undercutting of pavement, footing and slab area subgrades will be required if highly-plastic soils are exposed in immediate subgrades.

Shallow excavations (less than 8-10 ft deep) can likely be made with conventional earth moving equipment in good working order. Neat excavations should not be expected in sandy soils on the site. According to the proposed grading plans, minor cuts and fills on the order of +/- 3 to 8 feet are expected to achieve final site grades. SE does not expect bedrock to be encountered during construction.

Water was observed within all six (6) of the building borings performed as part of the field exploration. Depth to water ranged from 9 feet to 20 feet below existing grade, with an approximated average elevation of EL 210. The remaining borings did not encounter groundwater. Observations from the time of the field work indicate that there is currently standing water within the extents of the proposed construction. If water is allowed to sit at this location often, then it is possible that surface saturated soils will be encountered during construction. Infiltration testing results show that the site is likely not suitable for infiltration facilities (infiltration rate greater than 0.52"/hour required).

All materials and methods of construction for pavements should conform to the current *Maryland Department of Transportation Standard Specifications for Construction and Materials*, as implemented by Howard County.

As noted previously, Owners, Developers, and various Design Professionals for this project should not rely solely upon this Executive Summary and must read and evaluate the entire contents of this report prior to utilizing our evaluations and recommendations in the preparation of design and construction documents. Specialized Engineering should be contacted with any questions regarding this report.

2.0 PROJECT INFORMATION

2.1 PROPOSAL AND PROJECT AUTHORIZATION

SE's professional services for the MSP Tactical Services Operation and Command Building project were planned and performed in accordance with SE Proposal No. Q21-17512, dated May 14, 2021. The work was authorized with a signed contract.

2.2 PROJECT DESCRIPTION

The location of the planned building is shown on the Boring Location Plan in **Appendix A**. The site is located at the at 7777 Washington Boulevard, southeast of the intersection of Route 1 and Route 175 in Jessup, Maryland. The proposed construction includes two sites on the property, with the Command Building site located on the west side of the existing facility and the Explosives Containment Yard (ECY) on the southeast corner. There are several existing structures bordering the proposed sites including aluminum and steel frame, office and garage buildings. The Command Building site is relatively flat in the northwest corner and gently sloping upward to the other proposed building corners ranging from EL 222 up to EL 230. The ground cover is primarily grass and some trees. The ECY site is more steeply sloped downward, northwest to southeast, from EL 227 to EL 207.

SE has received preliminary plans showing the location of the proposed new Command Building and ECY pad. The plans show the Command Building to be a two-story building of approximately 13,000 SF per floor and the ECY pad is shown to be 34 feet by 70 feet, with a gravel drive leading up to it. Pavement parking lots are planned on two sides of the Command Building. Finished floor elevation is indicated to be EL 229. The project structural engineer provided the preliminary column live loads of approximately 100 kips and wall live loads of approximately 2 kips per linear foot (KLF). For the purposes of our recommendations, SE has assumed maximum column loads of 150 kips and maximum wall loads of 4 to 5 kips per linear foot.

According to the provided plans SWM facilities are planned along the west side of the Command Building and the south side of the drive up to the ECY pad. Due to the relatively flat nature of the site, SE assumes that only minor cuts and fills on the order of +/- 3 to 8 feet will be required to achieve final site grades.

If any of the noted information is incorrect or changes, you should inform Specialized Engineering so that SE can review the geotechnical data and amend the evaluations and recommendations presented in this report, if appropriate. SE's report has been developed for a specific set of project circumstances. If changes are made, SE should be afforded the opportunity to revise evaluations and recommendations to fit the revised circumstances. SE's geotechnical report was prepared, based on conditions found to exist during

exploration and professional judgement regarding how those conditions could affect the planned construction.

2.3 PURPOSE AND SCOPE OF SERVICES

The purpose of this study was to determine general subsurface conditions at the site and to evaluate the encountered conditions relative to geotechnical considerations for the planned construction.

The scope of services for this study included a site reconnaissance of the project area and determination of subsurface conditions through field exploration and laboratory testing. The study included evaluation of the site and subsurface conditions relative to the proposed construction and preparation of a report of findings, evaluations, and recommendations. The study was conducted to provide the following:

- A discussion of subsurface conditions encountered, including pertinent soil properties;
- An evaluation of the laboratory test results and subsurface conditions, as the conditions relate to the proposed site development;
- Geotechnical recommendations for site preparation, including placement and compaction of fill soils;
- Geotechnical recommendations in connection with the design and construction of building foundations, slabs-on-grade, and SWM facilities;
- Geotechnical design recommendations for expected pavements, including separate pavement designs for parking areas and drive pavements, if requested. SE has assumed CBR values for this effort – CBR testing is best done during construction, when the actual subgrade soils can be tested and evaluated.
- Recommendations for seismic site classification and site seismic response coefficients S_s and S_1 , in accordance with IBC 2015; and
- Comments and recommendations relating to other observed geotechnical conditions that could impact development, such as the presence of fills and/or expansive soils.

The scope of SE's geotechnical services did not include an environmental assessment for determining the presence or absence of wetlands or hazardous or toxic materials in the soil, bedrock, groundwater, and air, on or below or around this site. Any statements in this geotechnical report and/or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for the information of the Client.

Specialized Engineering did not provide any service to investigate or detect the presence of mold, moisture as related to mold, or other biological contaminants in or around any structure, or any service that was designed or intended to prevent or lower the risk of occurrence or amplification of the same.

2.4 SUBSURFACE EXPLORATION

From March 24 through March 25, 2022, SE's subsurface exploration sub-contractor drilled fourteen (14) soil test borings (B-1 to B-6, P-1 to P-4, and SWM-1 through SWM-4). The boring location plan used for performing the field work was based on our proposal and the plans made available to us at the time of our submission. Planned boring locations and depths were based on the building footprint, pavement areas and SWM facility locations.

The borings were drilled by a track-mounted drill rig, using continuous-flight, hollow-stem augers, and were extended to depths ranging from 10 to 20 feet below existing site grades. Upon completion of drilling, borings were backfilled with auger cuttings from the drilling operations.

The boring locations were laid out by the project civil engineer prior to the exploration work. Actual locations of drilled borings were very near the original planned locations. Ground surface elevations were interpolated from the topographic lines on the site plans provided by the client.

Drilling and soil sampling in the test borings were conducted in accordance with the procedures generally recognized and accepted as standard methods of exploration of subsurface conditions related to earthwork and foundation engineering projects. Representative soil samples were obtained by employing split-spoon sampling procedures in general accordance with ASTM D1586 test method. Soil samples obtained from the borings were identified according to boring number and depths, and a representative portion of each sample was sealed in a glass jar with lid to protect against moisture loss. The soil samples from the borings were subsequently transported to the Specialized Engineering laboratory for visual classification and further evaluation.

Soil samples obtained during the field investigation phase of the study will be stored for a period of 30 days from the date of this report. It will be necessary to discard the samples at the end of this storage period unless alternate disposition is arranged in advance.

The location of the site and the locations of the test borings are shown on the Boring Location Plan in **Appendix A**. Findings of Specialized Engineering's fourteen (14) soil test borings are presented on the Test Boring Logs presented in **Appendix B**.

2.5 LABORATORY TESTING

SE's professional staff visually classified the soil samples in the field and in the laboratory in general accordance with ASTM D2488. Tests for natural moisture content (ASTM D2216), Atterberg limits (ASTM D4318), and Grain-Size Analysis (ASTM D6913) were conducted on representative soil samples. Additionally, selected samples were submitted to the laboratory for Grain-Size Analysis with Hydrometer (ASTM D422) for USDA soil classification in the SWM borings. The laboratory test results are presented on the boring logs in **Appendix B** and on data sheets in **Appendix C**.

2.6 INFILTRATION TESTING

SE performed falling head infiltration testing at two SWM boring locations (SWM-3 and SWM-4). Infiltration testing was not performed at locations SWM-1 and SWM-2 due to the proposed raised bed design of the facilities. Infiltration testing was performed in general conformance with the *Maryland Stormwater Design Manual, Appendix D.1, Testing Requirements for Infiltration, Biroretention and Sand Filter Subsoils*.

At the SWM boring locations, an offset hole was performed and a PVC pipe was installed. Depths of testing were determined in the field based on standards contained within the MDE documentation for infiltration testing, as well as based on the relative densities and consistencies of the in-situ soils. **Table 2.1** below presents the results of the infiltration testing and the soil classification.

Table 2.1 – Summary of water levels in the soil test borings

Location	Depth of Infiltration Test (Elev)	Infiltration Rate	USDA Soil Classification
SWM-3	2.0 ft (219.5 ft)	0.03 in/hr	Sandy Loam
SWM-4	2.0 ft (207.0 ft)	0.11 in/hr	Silty Clay

The infiltration test results are below the MDE standard of 0.52 in/hr. SE does not believe that infiltration will be possible at this site. Per MDE specifications, an infiltration rate of 0.52 in/hr or greater is required for the use of infiltration BMP's. The relatively high percentage fines in the soils at SMW-3 and SWM-4 will not allow for water to infiltrate effectively. Additional infiltration testing may be required to seek approval for infiltration BMP's.

3.0 SITE AND SUBSURFACE CONDITIONS

3.1 SITE LOCATION AND DESCRIPTION

The project site is located at 7777 Washington Boulevard in Jessup, Maryland. The proposed site is at the existing Maryland State Police Waterloo Compound. **Figure 3.1** is an aerial image of the site area, which also shows nearby buildings and features. **Figure 3.2** is an excerpt of existing USGS topographic mapping of the site from the Savage topographic quadrangle map. The location of the site is also shown on the Boring Location Plan in **Appendix A**.

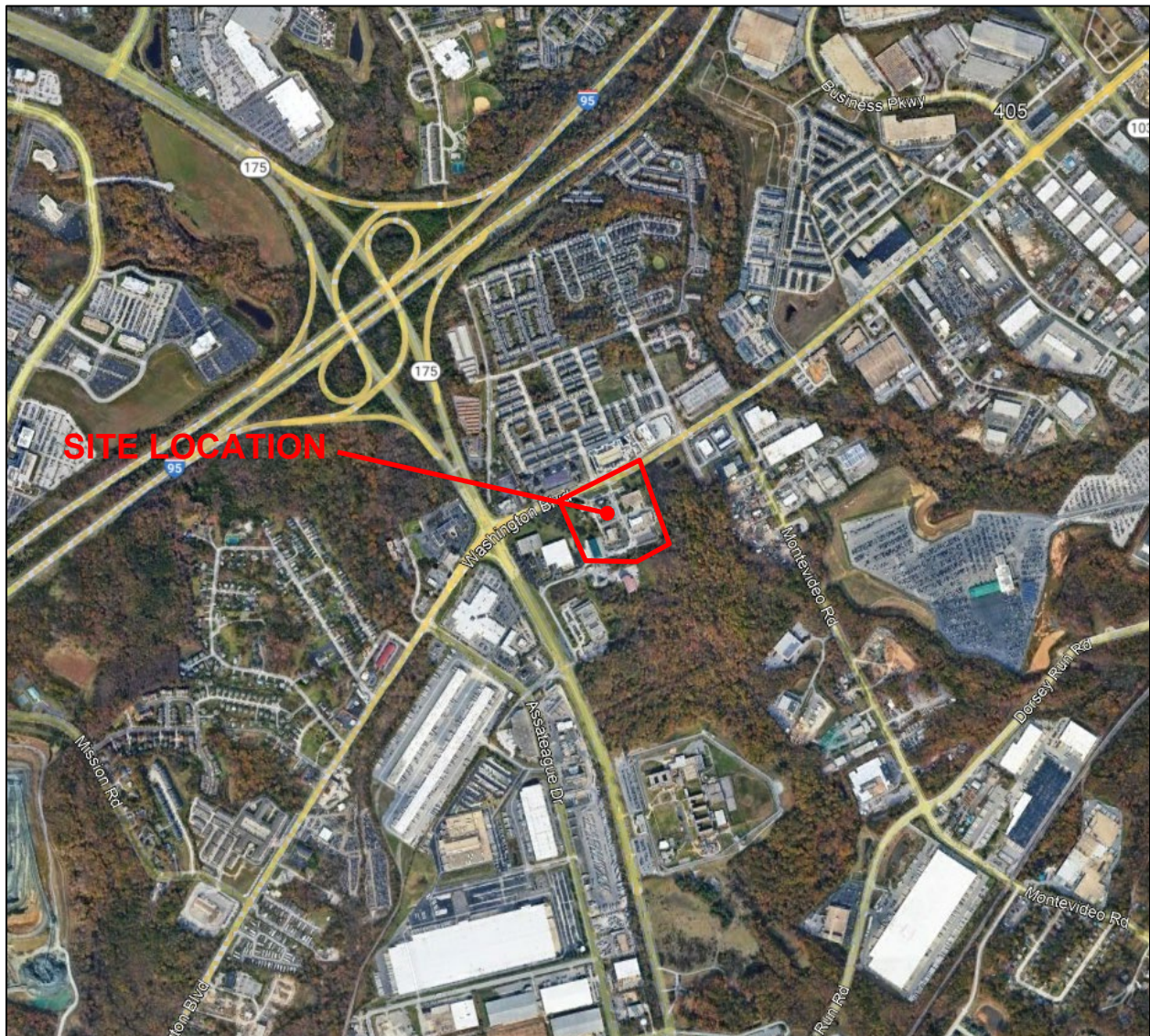


Figure 3.1 – Aerial image of the site area (from Google Earth)

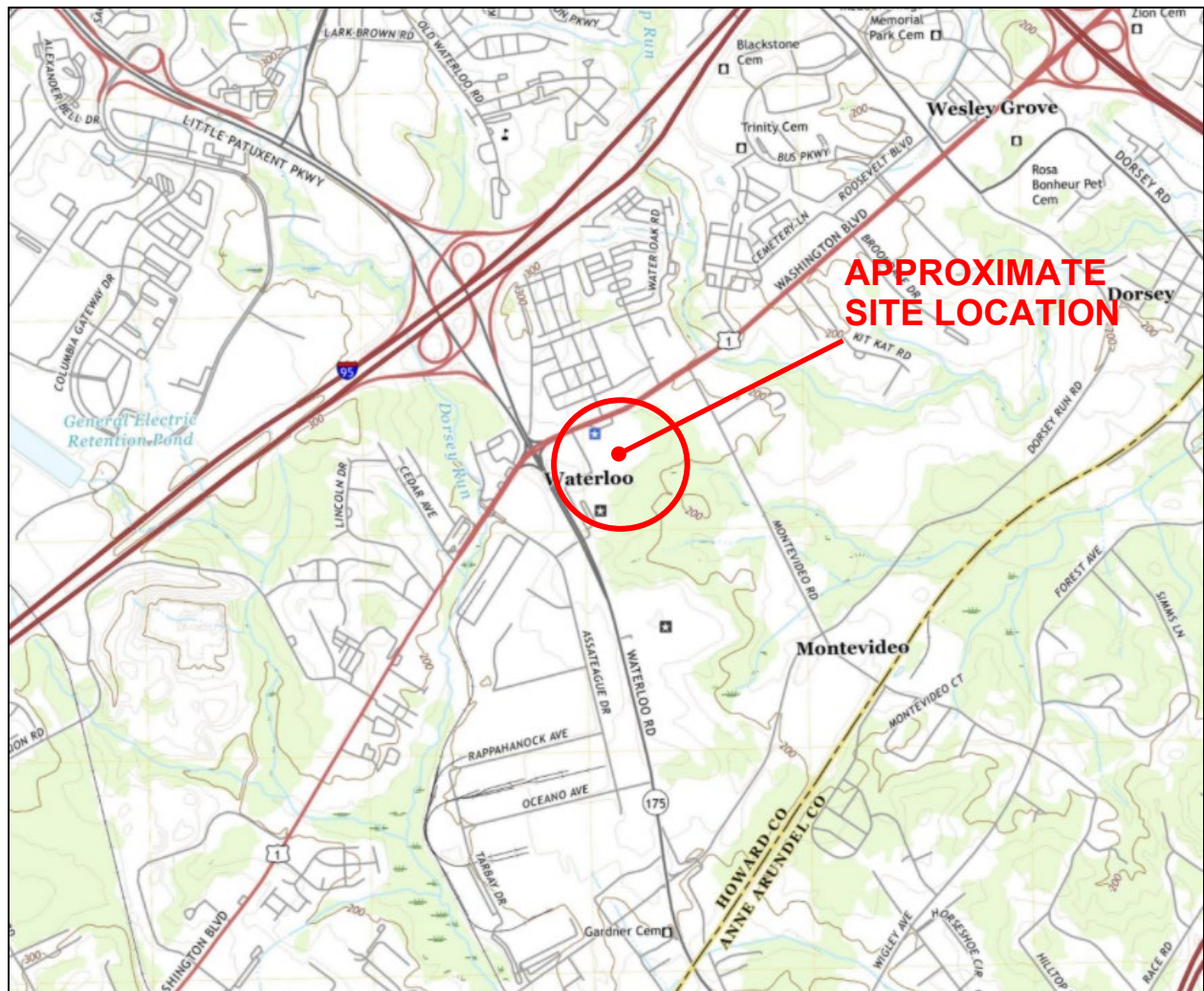


Figure 3.2 – Topographic mapping in the vicinity of the site
(from USGS, Savage quadrangle map, 2019)

3.2 AREA GEOLOGY

This geological background information is provided for a better understanding of the potential influence of the underlying bedrock on the proposed construction. Information regarding the geology in the area of the site has been published by the State of Maryland. The site is located in the Potomac Group – Patuxent Formation of the Coastal Plain physiographic province, and more specifically the Silt-Clay Facies. **Figure 3.3** is an

excerpt from “*Geologic Map of Howard County: Maryland Geological Survey; Jonathan Edwards, Jr.; 1993*”¹. **Figure 3.3** shows the local geologic formations.

The silt-clay facies of the Potomac group, of the Lower Cretaceous period, consists predominantly of clay, silt and clayey sand soils. The close geologic proximity to the sand-gravel facies leads to frequent mixing of the formations and layering of the silt-clay and sand-gravel facies.

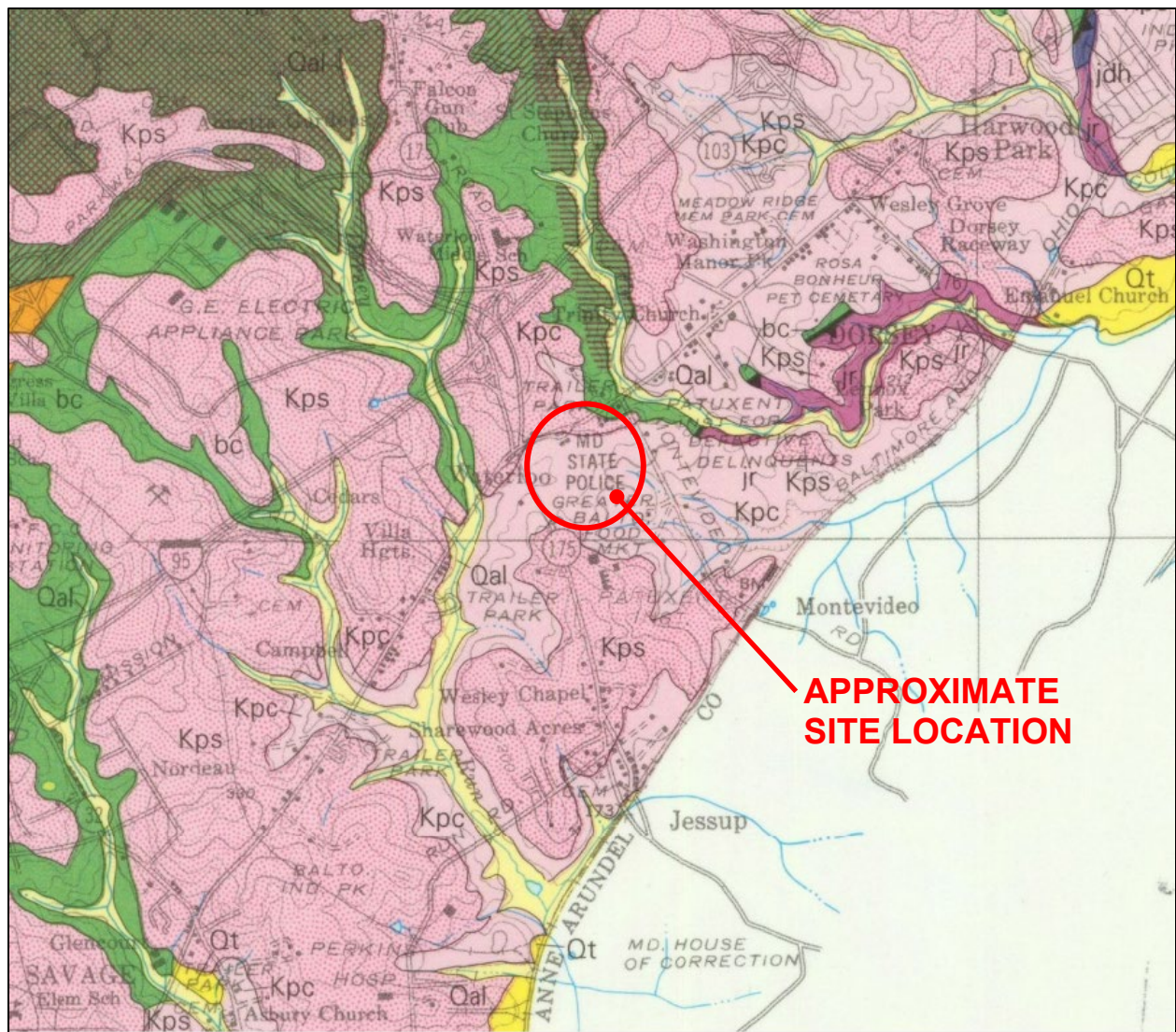


Figure 3.3 – Excerpt of geologic mapping in the area of the site (Edwards, 1993)

¹ *Geologic Map of Howard County: Maryland Geological Survey; Jonathan Edwards, Jr.; 1993*

3.3 SUBSOIL CONDITIONS

Fourteen (14) soil test borings were drilled on the site by SE's subcontractor. Generally, soils representative of the underlying Potomac Group were observed throughout the depths of the test borings. Some surficial fill soil was also encountered within the extent of the investigation. The materials noted to be fill on the boring logs appear to be primarily related to surface grading. Fill soils were very limited and localized. Weathered rock and bedrock were not encountered within the depths explored during the investigation.

Man-Placed Fill soils

Fill soils were observed in borings B-1 and SWM-1 up to a depth of 2.5 feet below existing grades. Based on the site plans provided by the client, SE believes that additional fill soils may exist along the proposed driveway to the ECY pad. The existing topography lines indicate that soil may have been placed there during the original site development.

Stratum I – Silt-Clay Soils

The silt-clay soils encountered in the borings were predominantly yellowish-brown, reddish-brown, and brown silt (ML) and clay (CL), with varying amounts of sand. Soils of Stratum I were observed at varying depths within the borings, consistent with the local geology and mixing of the two facies. We did not observe any highly plastic, fat clay or elastic silt soils (soils with a liquid limit greater than 50) at the site.

Clayey soils generally have some propensity for shrink-swell behavior, shrinking when dried and swelling when wetted. Laboratory testing of Atterberg limits was performed on six recovered soil specimens. Liquid limits (LL) varying between 31 and 36 were observed with plasticity indices (PI) observed varying between 13 and 17. SE does not expect significant shrink-swell behavior from the site soils tested. Atterberg limits test results are shown on the boring logs in **Appendix B** and in laboratory test results in **Appendix C**.

The silt-clay (fine-grained) soils generally had soft to hard relative consistencies with N-values (not counting surficial samples) typically varying between 6 and 31 bpf. Some intervals of very soft and soft soils were observed in the surficial soils at locations B-2, B-3, P-4, and SWM-2.

Stratum II – Sand-Gravel Soils

The sand-gravel soils encountered in the borings were predominantly yellowish-brown, orangish-brown and brown silty sand (SM), sand (SP/SW), and clayey sand (SC), with varying amounts of fines and gravels. Soils of Stratum II were observed at varying depths within the borings, consistent with the local geology and mixing of the two facies.

The sand-gravel (coarse-grained) soils generally had loose to dense relative densities with N-values (not counting surficial samples) typically varying between 4 and 47 bpf. One interval of very loose soil was observed in the surficial soils at location SWM-4.

3.4 GROUNDWATER CONDITIONS

The presence of free water was observed in six (6) of the fourteen (14) boring explorations. Borings were immediately backfilled upon completion, so no long-term water readings were taken. Water elevations were fairly consistent across the site between EL 206 and EL 211.

Table 3.1 – Summary of Water Levels in Soil Test Borings

Boring	Ground Surface Elevation	Depth to Water (ft / EL)
B-1	228.2	18.5 / 209.7
B-2	224.2	14.0 / 210.2
B-3	226.2	15.0 / 211.2
B-4	227.1	19.5 / 207.6
B-5	228.3	18.0 / 210.3
B-6	225.3	18.5 / 206.8
P-1	228.9	not encountered
P-2	225.1	not encountered
P-3	212.2	not encountered
P-4	212.0	not encountered
SWM-1	227.5	not encountered
SWM-2	224.5	not encountered
SWM-3	222.1	not encountered
SWM-4	208.8	not encountered

Fluctuation in groundwater levels should be anticipated with fluctuations in rainfall and from wetter to drier times of the year. SE believes perched groundwater could be encountered above denser materials (such as at the transition from soil to rock), or during wetter times of the year.

4.0 GEOTECHNICAL EVALUATION

The information developed during this study indicate that the subsoil and groundwater conditions are generally adaptable for the proposed development of the site, provided the recommendations provided in this report are followed.

Shallow foundations (continuous and spread footings) are considered adequate for the support of the proposed building. The footings should be supported on the undisturbed, suitable-bearing natural soils, except moderately to highly plastic clays and elastic silts ($LL > 40$ and $PI > 20$) wherever encountered, or on controlled structural fill placed on suitable natural soils.

However, if the column and wall loadings of the proposed structure are greater than the values assumed in this study, then SE should be afforded the opportunity to revise the recommendations presented within this report.

Shallow excavations (less than 8 to 10 feet deep) during the development of the site can generally be achieved with conventional earth-moving equipment (dozers, pans and hoes) in good working order. Neat excavations should not be expected in the sandy soils. Based on the proposed site layout and the existing site grades, SE expects that cuts and fills on the order of +/- 3 to 8 feet will be required for the proposed development of the buildings.

The soil test borings and existing topography lines indicate that there may be fill soils over portions of the site. Within the building footprint, undocumented fill soils, as well as soft and loose surficial soils may need to be removed prior to site development. The boring log data indicates that a layer of relatively soft and loose material exists at the surface and extends to depths of 2 to 3 feet below existing grades. SE believes that the flat site grades have allowed water infiltration over a long period of time potentially causing the surficial soils to become unsuitable to support loads. Site preparation and proof rolls, as described in **Section 5.1** of this report, will be critical in determining the possible extent to which these soils may exist, and whether or not the new fill can be placed directly on top of the existing soils or if removal of the soft/loose soils will be necessary. Footings may need to be extended below the soft/loose layer, if the layer is not removed and replaced.

Though not encountered within the extents of the investigation, highly-plastic soils may be present at the site and may be encountered during grading. Highly plastic soils should not be used as engineered fill. If highly plastic soils are encountered at slab subgrade levels or are exposed in excavations for foundations, the highly-plastic soils should be undercut and replaced to minimum depths of 4 feet below adjacent exterior grades. Furthermore, minimum 2-foot depths of undercut and replacement should be provided under pavements and sidewalks if highly plastic soils are encountered at subgrade levels.

SE does not expect a general groundwater level to be encountered in shallow excavations. However, if groundwater is encountered at shallower depths, it is SE's opinion that conventional dewatering measures, such as diversion ditches, interceptor drains, and sumps with pumps should be adequate for limited dewatering operations at the site during construction.

5.0 RECOMMENDATIONS

5.1 SITE PREPARATION & EARTHWORK

The following recommendations are intended for the satisfactory performance of site preparation and earthwork that may be needed to attain planned grades within footprint areas of proposed building, paved areas, and other site improvements.

Proof-rolling: Once the site has been cleared and planned subgrade levels exposed, the exposed subgrade conditions in the building areas should be carefully evaluated by Specialized Engineering. Proof-rolling should be performed across the entire site. Soils that are observed to rut or deflect excessively under the moving load should be under-cut and grades should be restored through placement and compaction of fill that meets the requirements listed below. All proof-rolling and under-cutting activities should be observed and evaluated by Specialized Engineering and should be performed during periods of dry weather. If proof-rolling is not practical, dynamic cone penetration tests can be performed by Specialized Engineering's field representatives to evaluate subgrade conditions.

Earthwork: Efforts should be made to keep construction areas free of ponding water. Subgrade strength may be reduced if soils are exposed to construction traffic and increases in moisture content, possibly resulting in the need for under-cut excavations.
Frozen soils cannot be used as fill or backfill.

If under-cutting is needed at isolated locations during subgrade preparation and inspection, the following recommendations are intended for the satisfactory performance of the earthwork that may be needed to provide planned grades within the footprint area of the building pad and paved areas.

- Materials satisfactory for use as controlled fill include clean soil or bankrun sand and gravel (GW, GM, and SM), provided the soils meet the dry density and plasticity requirements outlined below:

Maximum Dry Density	≥ 105 pcf, standard proctor
Liquid Limit (%)	≤ 40
Plasticity Index	≤ 20

- ML, CL, GC and SC materials also can be used as engineered fill, provided the soils meet the dry density and plasticity requirements outlined above and are approved by the Geotechnical Engineer.
- Highly plastic soils (CH & MH soils) should not be used as engineered fill.
- The fill materials should be free from topsoil, organics and rock fragments having a major dimension greater than 3 inches.

- The moisture contents of fill should be maintained within plus or minus two (± 2) percentage points of the optimum moisture content.
- Fill placement should be in maximum 8-inch thick, loose, horizontal lifts uniformly compacted.
- Engineered Fill/Structural Fill should be compacted to at least ninety-eight percent (98 percent) of the maximum dry density as established by ASTM D 698 test method (standard Proctor).
- The compaction for the drive lanes and other paved areas should be governed by the AASHTO T-180 Method (modified Proctor). Requirements for degree of compaction should conform to current Howard County requirements and Sections 204, 208, and 501 of the Maryland DOT *Standard Specifications for Construction and Materials* (latest edition) as listed below:
 - Aggregate Subbase/Base Course 97 percent modified proctor
 - Subgrade 97 percent modified proctor
 - The entire thickness of fill up to 12 92 percent modified proctor
 inches below the subgrade elevations

The moist contents of fill material used for pavements should be within (± 2) percentage points of the optimum moisture content for the materials being used.

- Adequate surface drainage should be provided at the site to reduce increases in moisture contents of the foundation and pavement subgrade soils. Excavations should be backfilled as soon as possible to preclude collection and ponding of surface water runoff. Excavations that do fill with water should be immediately pumped, so that infiltration of collected water into the subsurface can be reduced. Grades in pavement areas and grades immediately adjacent to the structure should be sloped away from the structure to prevent ponding of water. In addition, SE discourages the planting of shrubs that will require routine watering immediately adjacent to the building.

For proper site preparation, the earthwork operations should be observed and tested by a qualified representative of the Geotechnical Engineer.

Limited Space Backfilling: Limited spaces are defined as areas where backfill operations are restricted to the use of small mechanical compaction equipment. Most deficiencies in compacted backfill around subsurface structures have occurred in limited spaces, where required densities are difficult to achieve because of restricted working room and where relatively low compaction effort is provided by the compaction equipment used.

- All structural backfill, including that placed in limited spaces, must be systematically compacted to the project requirements, even if crushed aggregate is placed.
- Oversized rock fragments should not be placed around pipes or other below-ground structures.
- Proper placement and compaction of backfill around pipes, conduits and utility lines is often difficult and should be given special attention.
- Clearly defined project specifications for confined zone backfill compaction and sufficient field monitoring is essential in preventing problems associated with utility trench backfill settlement.
- Also, backfilling in limited access areas, such as in utility trenches and around below-grade structures such as manholes, junction boxes, and curb inlets, **should have a loose-lift thickness limited to 4 to 6 inches.**
- A sufficient amount of testing or observation should be conducted to verify that proper compaction is achieved. In extremely tight spaces, use of alternate backfill materials, such as flowable fill, should be considered.

5.2 FOUNDATIONS

As stated earlier, the proposed building can be supported on conventional shallow foundations (continuous and spread footings) bearing on the existing soils of Stratum I, II or controlled structural fills, provided the supporting subgrade soils are prepared in accordance with **Section 5.1** "Site Preparation and Earthwork" and the footings are proportioned based on an allowable bearing capacity not to exceed 2,500 psf. Specialized Engineering does not recommend that the footings be allowed to bear on the soils located in the top 2 to 3 feet below the existing grades. As stated previously these soils were found to be loose and soft and likely not suitable for supporting building loads.

However, if the column and wall loadings of the proposed structure are considerably higher than values assumed in this study, then SE should be afforded the opportunity to revise the recommendations presented within this report.

The project structural engineer provided the preliminary column live loads of approximately 100 kips and wall live loads of approximately 2 kips per linear foot (KLF). For the purposes of our recommendations, SE has assumed maximum column loads of 150 kips and maximum wall loads of 4 to 5 kips per linear foot.

While highly plastic soils were not encountered during the investigation, the foundations should not be supported on moderately to highly plastic clays or elastic silts with $LL > 40$ and $PI > 20$. Because of their known high shrink/swell potential and its detrimental effects

on building foundations, these soils, when encountered at or below the foundation subgrade(s), should be excavated in their entirety from below the foundation subgrade(s) or to at least 4 feet below the adjacent exterior finished grade, whichever is shallower. The excavated soils should then be replaced with approved controlled fill. Alternatively, the foundations can be lowered to 4 feet below the adjacent exterior finished grade when supported on these soils.

Continuous foundations that are partially located in fill and partially in undisturbed soil formation, should be designed as grade beams, 5 feet on either side of the transition. The column footings, in similar circumstances, should be extended into the underlying undisturbed soils.

The footings may be sized and designed on the basis of allowable bearing pressures indicated below, subject to observation and approval of soil conditions at the bottom of footing excavations for suitable soil bearing by the Geotechnical Engineer of Record or his qualified representative:

Table 5.1 – Summary of the Allowable Bearing Capacity

Soil Conditions At Subgrade	Range of Allowable Bearing Pressure (psf)	Minimum Width of Footings (inches)
Undisturbed Soils of Strata I, II Or Controlled Structural Fill Isolated Footings Continuous Footings	 2,500 2,500	 30 30

Depth of Footings: The embedment depths of all footings are governed by bearing capacity needs and minimum depth requirements for protection against frost heave in accordance with the International Building Code (IBC 2015). The depth of frost is approximately 30 inches in the Jessup area. Therefore, SE recommends that the bottoms of footings be located at least 30 inches below the lowest adjacent finished exterior grades.

Anticipated Settlement: SE believes total settlement up to 1-inch should be expected for conventional shallow foundations. It is anticipated that total settlements not exceeding 1 inch should limit differential settlements to about ¾-inch over a 30-ft span between adjacent column footings or along a loaded wall.

Footing Excavations: Water and/or loose soil may collect in footing excavations as a result of disturbance, surface precipitation, and near ground surface seepage. Therefore:

- Water and loosened or softened soils should be removed from the bottoms of footing excavations before reinforcing steel and concrete are placed.
- Footing excavations should not be left open for long periods. If concrete cannot be placed during the same day that a footing excavation is made, the bottom of the footing excavation should be protected by undercutting 3 inches and placing a 3-inch-thick, lean-mix (2,000 psi) concrete working mat (mud-mat) immediately upon approval of bearing conditions and before placement of reinforcing steel.

5.3 SLABS-ON-GRADE

SE was not provided anticipated loading conditions for floor slabs. Based on similar projects, SE recommends that floor slabs be designed using a modulus of subgrade reaction of 100 pounds per cubic inch (pci).

Typically, slabs should be underlain by a minimum of four (6) inches of compacted aggregate material in order to achieve uniform support and to provide a capillary break between the subgrade soils and the slab concrete. A maximum particle size of one inch is recommended for the aggregate material. SE emphasizes the importance of vibro-compacting the underslab aggregate layer prior to floor slab construction.

The use of a moisture vapor retarding barrier between the aggregate layer and the bottom of the floor slab should be at the discretion of the Architect, who can evaluate the potential impact of water vapor transmission on floor coverings and interior furnishings.

In order to control slab cracking, floor slabs should be jointed in accordance with ACI guidelines, and any crack control inclusion such as wire mesh should be permanently supported in its proper position and not pulled up with hook bars during concrete placement. Column points and periphery walls should be isolated from the floor slabs to minimize the possibility of the floor slab cracking due to relative displacements.

On most projects, there is some delay between initial grading and the time when the Contractor is ready to construct the slab-on-grade. Although, the near surface soils may have been placed and compacted adequately or exhibited a high consistency during initial grading, exposure to weather, construction traffic, and other factors can destroy the integrity of the subgrade soils. On many projects, it becomes a point of controversy when remedial work is required to establish proper floor slab support. Prior to the construction of concrete floors, the subgrade should be thoroughly proof-rolled and compacted to create a uniform high density. SE recommends that the construction specifications include provisions for the restoration of the subgrade soils to an acceptable condition prior to the construction of floor slabs.

5.4 SEISMIC SITE CLASSIFICATION

Based on the subsurface conditions encountered at the site, the structural design should use the following site coefficients for seismic design based on Section 1615 of the International Building Code (2015) shown in **Table 5.2**. SE recommends a seismic site classification of “D”.

Table 5.2 – Summary of Seismic Site Classification

Seismic Site Class	D
Spectral response acceleration at short periods, S_s	0.15
Spectral response acceleration at 1-second period, S_1	0.041
Site coefficient, F_a	1.6
Site coefficient, F_v	2.4

The information in **Table 5.2** is based on SE’s use of the online ASCE 7 Hazard Evaluation software application and USGS published data.

Based on information obtained from our soil test borings and our review and knowledge of local geology, it is SE’s opinion that the potential for liquefaction of the soils at the site due to earthquake activity is low.

5.5 PAVEMENT DESIGN

The pavement areas should be prepared as recommended in **Section 5.1** of this report, “Site Preparation”. Site preparation for pavement areas should include proof-rolling of the exposed subgrade prior to construction of the pavement section. If highly-plastic soils are encountered at or near subgrade levels, the highly-plastic soils should be undercut and replaced with suitable soils to depths of at least 2 ft below the pavement subgrade levels.

For preliminary pavement design, an average California Bearing Ratio (CBR) value of 3 has been assumed for the on-site soils. It is recommended that the preliminary design CBR value be confirmed through laboratory testing following completion of grading operations at the time of construction, when subgrade conditions can be better evaluated. Any necessary adjustments to pavement designs can be made at that time. It is possible that the additional testing could result in CBR values that are higher than the preliminary CBR value suggested in this report. In that case, the final pavement section possibly could be reduced in thickness, thereby resulting in possible cost savings during construction.

The design of a pavement section depends primarily on the stiffness of the supporting subgrade (as reflected by the CBR value) and on anticipated traffic loads. Estimated traffic loads and intensities for the proposed roadways were not provided to us. Therefore, SE estimated traffic loads for the proposed roadway, based on our experience with similar type facilities.

A preliminary pavement section is shown in **Table 5.3**. The paving section has been designed based on a design CBR value of 3 and a 20-year design period for the pavement. For the preliminary design purposes of parking areas, SE has assumed design equivalent single axle loads (ESALs) for the above estimated traffic volume to be on the order of 25,000 and 100,000 for the parking areas and drive lanes, respectively. If the actual ESAL values will differ from the values presented above, Specialized Engineering should be notified, so that the recommendations presented in this section can be re-evaluated.

All material and methods of construction for pavements should conform to the current Maryland Department of Transportation *Standard Specifications for Construction and Materials*.

The indicated asphalt pavement sections may not be adequate for areas exposed to heavy static loads or dynamic loads induced by braking, starting and turning of loaded dumpster trucks, delivery trucks or other such vehicles (such as the EYC pad or near any dumpsters). Heavier sections consisting of rigid (concrete) pavements can be considered for these areas. The heavier section should consist of at least 5-inches thick (4000 psi mix), and underlain by at least a 5-inch thick layer of stone aggregate base. SE suggests the total thickness of the rigid pavement section (i.e., concrete and crushed stone) match the total thickness of the adjacent pavements in order to facilitate grading.

Base stone and pavement should be placed immediately after final soil subgrade approval has been obtained due to the potential for subgrade softening from adverse weather conditions. In addition, heavy construction traffic should be prevented from traveling across approved final subgrade areas in order to help maintain a stable subgrade prior to pavement construction.

Pavement subgrades should be graded such that water does not become ponded or entrapped on or beneath the pavement system. If adequate drainage cannot be obtained by crowning the subgrade, an appropriately designed underdrain system should be used. Also, care should be taken to seal all pavement joints and cracks and maintain proper surface water drainage.

As preliminary pavement subgrades are often damaged by on-going construction, on many projects, it becomes a point of controversy when remedial work is required to complete pavement construction. SE recommends that the construction specifications include provisions to establish responsibility for any repair of the final pavements.

Table 5.3 – Flexible (asphalt) Pavement Designs

Pavement Layer		Drive Lanes	Parking Areas
Asphaltic Concrete Surface Course Thickness (HMA-Superpave-12.5 mm: PG 64-22, Level 2)		1.5"	1.5"
Asphaltic Concrete Base Course Thickness (HMA-Superpave-19 mm: PG 64-22, Level 2)		2.5"	2.0"
Graded Aggregate Base Course (GAB) Thickness		9.0"	6.0"
*NOTES:	1.)	Hot Mix Asphalt Surface and Base Course material should meet the specifications in Sections 901 and 904 of the most recent Maryland Department of Transportation <i>Standard Specifications for Construction and Materials</i> .	
	2.)	Aggregate Base Course material should meet the specification in Section 901.01 of the most recent Maryland Department of Transportation <i>Standard Specifications for Construction and Materials</i> .	
	3.)	Hot Mix Asphalt (HMA) Surface and Base Courses should be placed in accordance with Section 504 of the most recent Maryland Department of Transportation <i>Standard Specifications for Construction and Materials</i> .	
	4.)	Aggregate Base Course should be placed in accordance with Section 501 of the most recent Maryland Department of Transportation <i>Standard Specifications for Construction and Materials</i> .	
	5.)	Aggregate base course should be placed on a subgrade capable of obtaining a minimum CBR value of 3 when compacted to 97 percent of maximum dry density per Modified Proctor (AASHTO T 180).	

5.6 STORMWATER FACILITIES

The results of the infiltration testing indicate that infiltration facilities are likely not feasible for use at this site. Refer to Section 2.6 for full details and results of infiltration testing. Conventional Best Management Practices (BMPs) can be used, but with provisions for underdrain systems and other means for precluding infiltration of stored or treated stormwater.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 CONSTRUCTION QUALITY CONTROL

To assess that the in-situ soil conditions, or those developed during construction, are as anticipated during the design stage, qualified representatives of the Geotechnical Engineer should provide observation and testing services during construction, as follows:

- Soils from cut areas should be sampled and tested to determine their suitability for use as new engineered fill associated with proposed construction;
- Subgrade areas for construction of site improvements should be monitored and tested to verify that the prepared subgrades will adequately support the planned construction;
- Construction of foundations, slabs, pavements, retaining walls, and other site improvements should be observed and tested to verify general compliance with project design and construction documents.

6.2 RESPONSIBILITY OF THE DEVELOPER

Review and approval of drawings, specifications and reports by the municipal authorities, with or without recommendations, should in no way relieve the Developer of the responsibility for design, construction and performance of the structures on the project site and damage to surrounding properties.

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, Part 1926, Subpart P". This document was issued to better allow for the safety of workers entering trenches or excavations. It is mandated by this federal regulation that excavations, whether the excavations are utility trenches, basement excavations, or footing excavations, be constructed in accordance with the new OSHA guidelines. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the Contractor could be liable for substantial penalties.

The Contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The Contractor's "responsible person", as defined in 29 CFR, Part 1926, should evaluate the soil exposed in the excavations as part of the Contractor's safety procedures. In no case, should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in all local, state, and federal safety regulations. We are providing this information solely as a service to our client. Specialized Engineering

does not assume responsibility for construction site safety or the Contractor's or other parties' compliance with local, state, and federal safety or other regulations.

7.0 REPORT LIMITATIONS

This report has been prepared for the exclusive use of the **Noelker and Hull Associates, Inc. and their design consultants** for application to geotechnical-related design and construction considerations for the Maryland State Police Tactical Services Operations and Command Building and Explosives Containment Yard (ECY) located at 7777 Washington Boulevard in Jessup, Maryland. The findings, evaluations, recommendations, specifications, and professional advice contained in this report have been provided specifically for the referenced project and are considered in accordance with generally accepted professional geotechnical engineering practices in the local area at the time of the study. No warranties are implied or expressed.

Field exploration and laboratory testing programs associated with this study were limited, in that the assessment of subsurface conditions was based on widely-spaced borings. Therefore, conditions represented by the test borings should be considered applicable only at the boring locations, at the time the borings were made. Subsurface conditions might be different at other locations and at other times. During the course of the study, Specialized Engineering's Professional Staff may have adjusted the originally proposed scope of services, in order to accommodate encountered conditions, equipment capabilities, the Client's schedule, budgetary considerations, and other factors. For these reasons, some deviations from site and subsurface conditions considered for this study could exist and could be encountered during the course of construction. In addition, during the course of project planning, design, and construction, project characteristics could change from the specific project characteristics considered during preparation of this report.

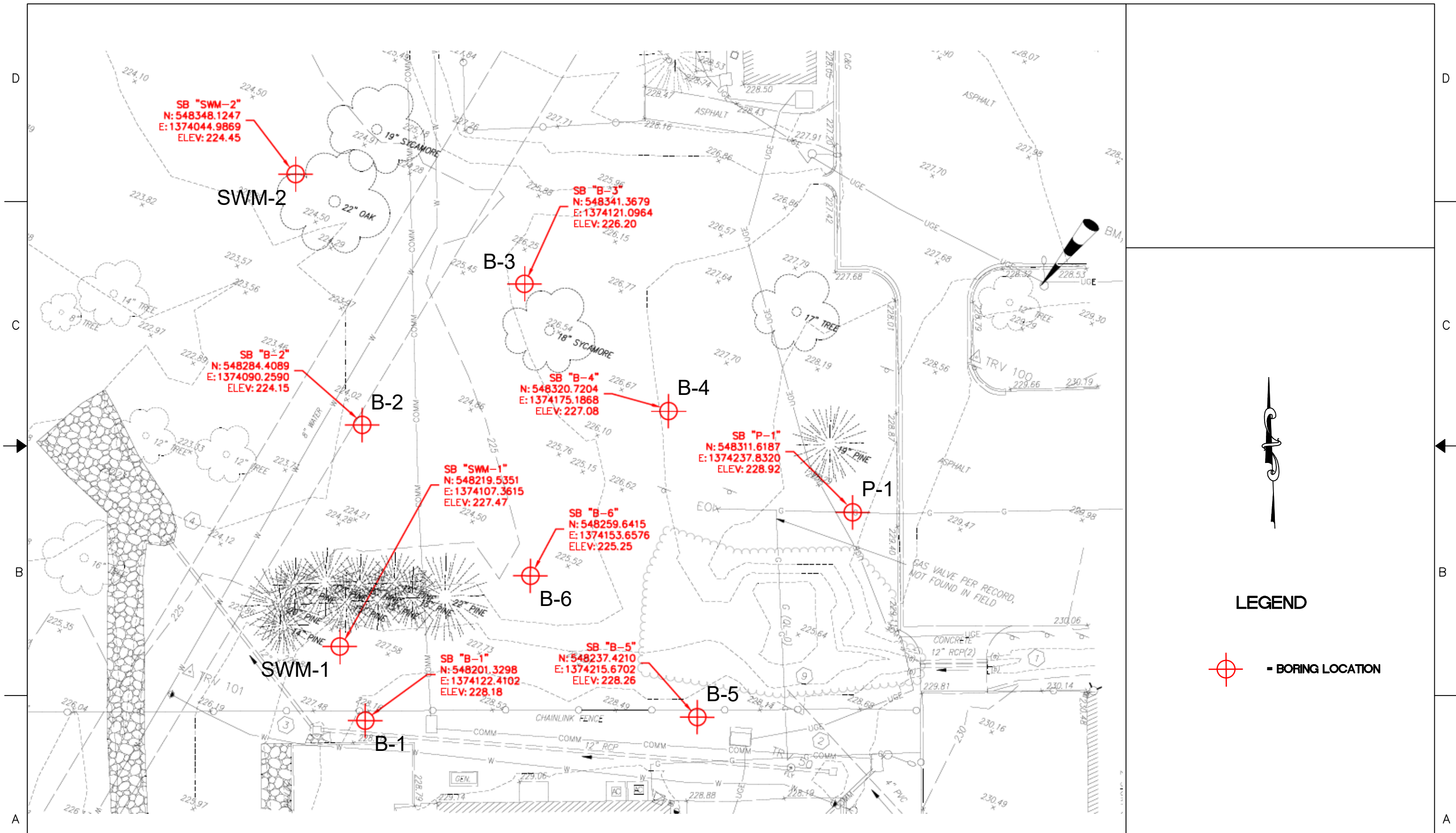
If changed conditions occur or are encountered, the Client should immediately advise Specialized Engineering of the changed conditions to determine if the changed conditions could impact the evaluations and recommendations provided in this report. If Specialized Engineering is not retained to perform such evaluations, Specialized Engineering will not be responsible for the impact of the changed conditions on the geotechnical evaluations and recommendations presented in this report.

The geotechnical-related evaluations and recommendations presented in this report are based on the project characteristics discussed and our Professional Engineers' interpretations of the subsurface conditions revealed by the subsurface exploration activities. Specialized Engineering is not responsible for interpretations by others of the data or the findings, evaluations, and recommendations provided in this report. Therefore, after project documents are more complete, Specialized Engineering should be retained and provided the opportunity to review pertinent project documents to determine whether our engineering evaluations and recommendations have been properly interpreted and incorporated into the documents. At that time, Specialized Engineering may need to provide supplementary evaluations and recommendations.


Specialized Engineering recommends that the project specifications contain a statement indicating that this report is for informational purposes only and should not be considered part of the contract documents. The data contained in this report may not be adequate for Contractors' specific needs, in which case the Contractors should make their own tests and analyses prior to bidding work or preparing proposals associated with the proposed construction. Contractors may not rely on this report to assess field conditions other than those specifically addressed in the evaluations and recommendations presented in this report. Field conditions could be more difficult than the Contractors anticipate and, therefore, should be directly observed and evaluated by the Contractors.

APPENDIX A
BORING LOCATION PLAN





LEGEND


- BORING LOCATION

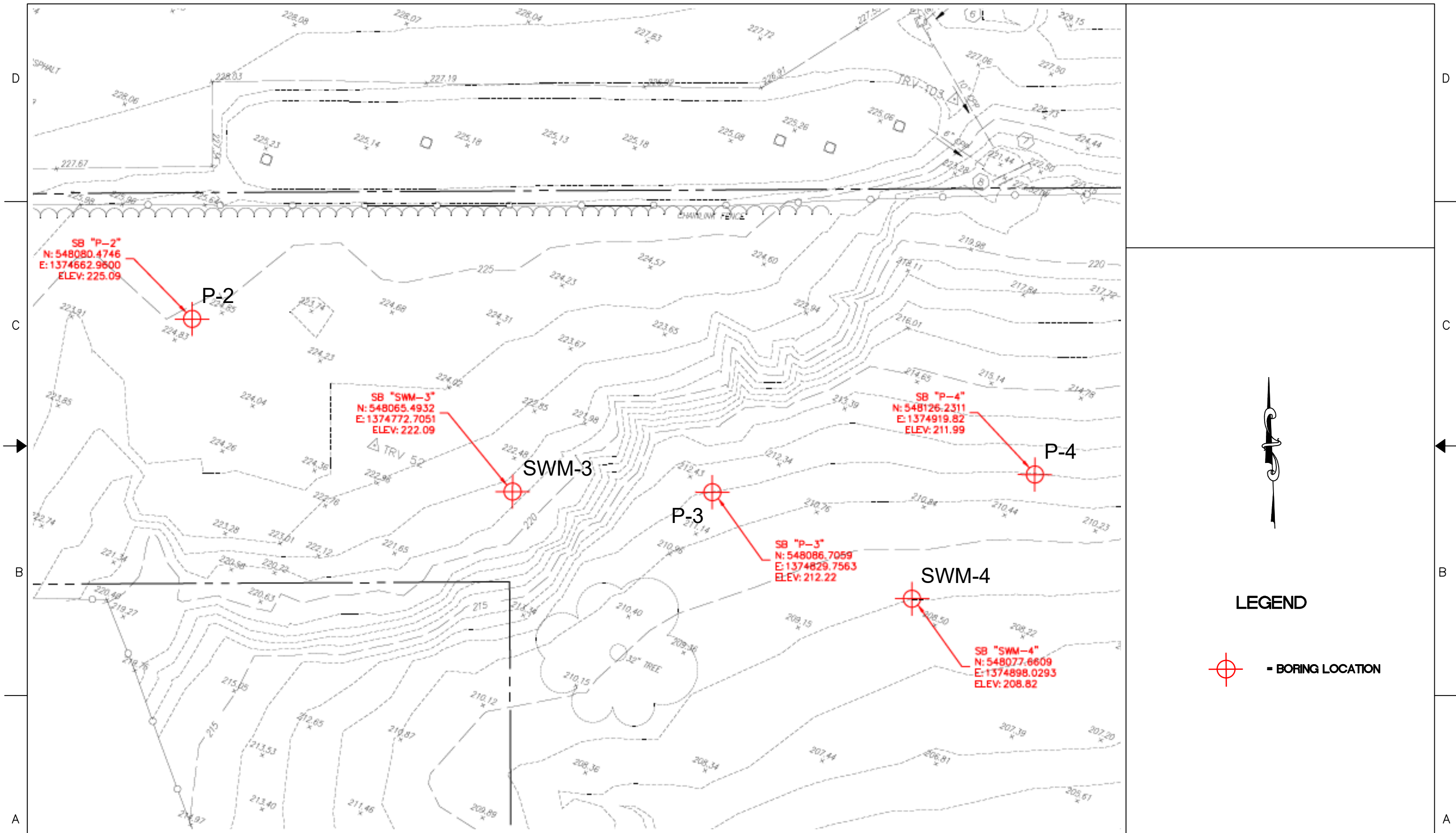
TACTICAL ADMINISTRATION BUILDING
SPECIALIZED ENGINEERING PROJECT NO: 218680
 WATERLOO BARRACK 7777
 JESSUP, MD

SPECIALIZED ENGINEERING
Construction Quality Control • Environmental Consulting
 Geotechnical & Forensic Engineering
 7504 Connelley Drive, Suite G, Hanover, Maryland 21076
 Phone: 410-768-4800 Fax: 410-768-4803

NO.	DATE	REVISIONS	BY	CHK	APP'D
2	04/21/22	REVISED - AS-DRILLED	JJC	ILH	ILH
1	03/16/22	REVISED	ILH	DSS	DSS
0	03/01/22	ISSUED FOR USE	ILH	DSS	DSS

SCALE: N.T.S. DESIGNED: _____ DRAWN: ILH

SPECIALIZED ENGINEERING HANOVER, MD		
BORING LOCATION PLAN - SHEET 1		
JOB NO. 218680	DRAWING NUMBER 218680-01	REV 0



LEGEND

 - BORING LOCATION

TACTICAL ADMINISTRATION BUILDING
SPECIALIZED ENGINEERING PROJECT NO: 218680
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2	04/21/22	REVISED - AS-DRILLED	JJC	ILH	ILH
1	03/16/22	REVISED	ILH	DSS	DSS
0	03/01/22	ISSUED FOR USE	ILH	DSS	DSS
NO.	DATE	REVISIONS	BY	CHK	APP'D
SCALE	N.T.S.	DESIGNED	DRAWN: ILH		

SPECIALIZED ENGINEERING
 HANOVER, MD
BORING LOCATION PLAN - SHEET 2

JOB NO.	DRAWING NUMBER	REV
218680	218680-02	0

11 x 17" SIZE

APPENDIX B
TEST BORING LOGS



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Geotechnical & Forensic Engineering

BORING NUMBER B-1

PAGE 1 OF 1

CLIENT Noelker and Hull Associates, Inc.

PROJECT NAME Maryland State Police TSO & Command Building

PROJECT NUMBER 218680

PROJECT LOCATION Washington Boulevard, Jessup, MD

DATE STARTED 3/24/22 COMPLETED 3/24/22

GROUND ELEVATION 228.18 ft HOLE SIZE 3.25" in.

DRILLING CONTRACTOR Connelly and Associates, Inc.

GROUND WATER LEVELS:

DRILLING METHOD HSA

▽ AT TIME OF DRILLING 18.5 ft / Elev 209.7 ft

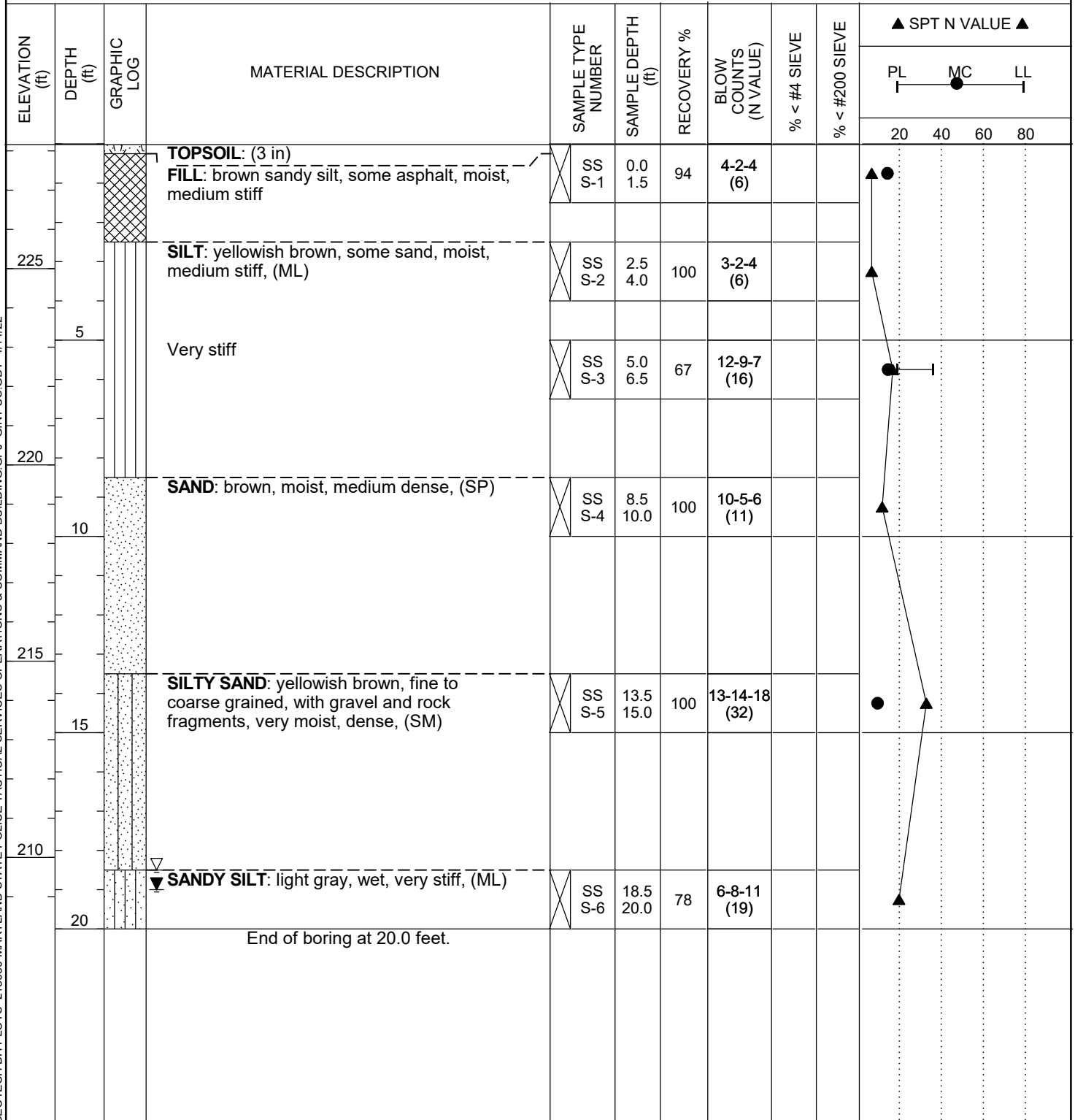
LOGGED BY C. Seong CHECKED BY J. Cook

▼ AT END OF DRILLING 19.0 ft / Elev 209.2 ft

NOTES Cave-in = 6 ft

24hrs AFTER DRILLING Dry

GEOTECH\BH PLOTS 218680 MARYLAND STATE POLICE TACTICAL SERVICES OPERATIONS & COMMAND BUILDING.GPJ GINT US.GDT 4/14/22



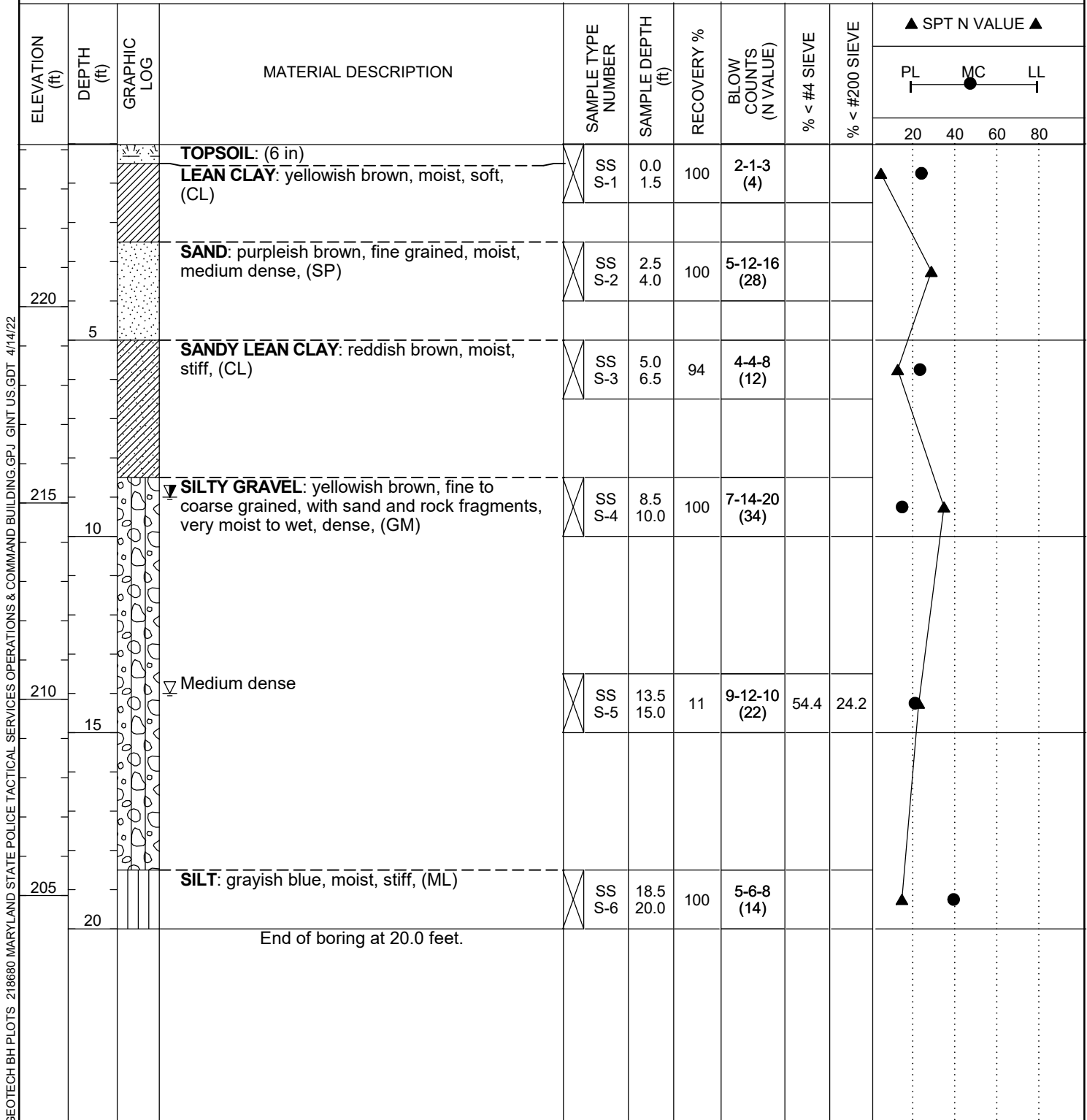
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BORING NUMBER B-2

PAGE 1 OF 1

CLIENT Noelker and Hull Associates, Inc.	PROJECT NAME Maryland State Police TSO & Command Building
PROJECT NUMBER 218680	PROJECT LOCATION Washington Boulevard, Jessup, MD
DATE STARTED 3/25/22	COMPLETED 3/25/22
DRILLING CONTRACTOR Connelly and Associates, Inc.	GROUND ELEVATION 224.15 ft
DRILLING METHOD HSA	HOLE SIZE 3.25" in.
LOGGED BY C. Seong	CHECKED BY J. Cook
NOTES Cave-in = 15 ft	GROUND WATER LEVELS:
	▽ AT TIME OF DRILLING 14.0 ft / Elev 210.2 ft
	▽ AT END OF DRILLING None
	▽ 48hrs AFTER DRILLING 9.0 ft / Elev 215.2 ft



SPECIALIZED ENGINEERING

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BORING NUMBER B-3

PAGE 1 OF 1

CLIENT Noelker and Hull Associates, Inc.

PROJECT NAME Maryland State Police TSO & Command Building

PROJECT NUMBER 218680

PROJECT LOCATION Washington Boulevard, Jessup, MD

DATE STARTED 3/24/22 COMPLETED 3/24/22

GROUND ELEVATION 226.20 ft HOLE SIZE 3.25" in.

DRILLING CONTRACTOR Connelly and Associates, Inc.

GROUND WATER LEVELS:

DRILLING METHOD HSA

▽ AT TIME OF DRILLING 15.0 ft / Elev 211.2 ft

LOGGED BY C. Seong CHECKED BY J. Cook

▼ AT END OF DRILLING 20.0 ft / Elev 206.2 ft

NOTES Offset 5 ft NW, Cave-in = 12.5 ft

▼ 24hrs AFTER DRILLING 10.0 ft / Elev 216.2 ft

GEOTECH\BH PLOTS 218680 MARYLAND STATE POLICE TACTICAL SERVICES OPERATIONS & COMMAND BUILDING.GPJ GINT US.GDT 4/14/22

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	SAMPLE DEPTH (ft)	RECOVERY %	BLOW COUNTS (N VALUE)	% < #4 SIEVE	% < #200 SIEVE	▲ SPT N VALUE ▲			
										PL	MC	LL	
225	0.0	[Hatched pattern]	TOPSOIL: (6 in)	SS S-1	0.0	100	2-1-2 (3)						
	1.5	[Hatched pattern]	LEAN CLAY: brown, moist, soft, (CL)										
	2.5	[Vertical lines]	SILT: dark brown, with clay, moist, stiff, (ML)	SS S-2	2.5	72	WOH-5-8 (13)						
	4.0	[Vertical lines]											
220	5.0	[Vertical lines]	SANDY SILT: orangish brown, moist, very stiff, (ML)	SS S-3	5.0	56	10-9-11 (20)						
	6.5	[Vertical lines]											
	8.5	[Vertical lines]	SILTY SAND: yellowish brown to black, fine to coarse grained, with gravel and rock fragments, very moist to wet, dense, (SM)	SS S-4	8.5	72	10-21-18 (39)						
	10.0	[Vertical lines]											
215	13.5	[Vertical lines]		SS S-5	13.5	61	7-14-24 (38)						
	15.0	[Vertical lines]											
210	18.5	[Vertical lines]	SILT: grayish blue, moist, very stiff, (ML)	SS S-6	18.5	100	5-8-10 (18)						
	20.0	[Vertical lines]	End of boring at 20.0 feet.										

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BORING NUMBER B-4

PAGE 1 OF 1

CLIENT Noelker and Hull Associates, Inc.

PROJECT NAME Maryland State Police TSO & Command Building

PROJECT NUMBER 218680

PROJECT LOCATION Washington Boulevard, Jessup, MD

DATE STARTED 3/24/22 COMPLETED 3/24/22

GROUND ELEVATION 227.08 ft HOLE SIZE 3.25" in.

DRILLING CONTRACTOR Connelly and Associates, Inc.

GROUND WATER LEVELS:

DRILLING METHOD HSA

▽ AT TIME OF DRILLING 19.5 ft / Elev 207.6 ft

LOGGED BY C. Seong CHECKED BY J. Cook

▼ AT END OF DRILLING 12.0 ft / Elev 215.1 ft

NOTES Offset 5 ft E, Cave-in = 11.5 ft

▼ 24hrs AFTER DRILLING 12.0 ft / Elev 215.1 ft

GEOTECH\BH PLOTS 218680 MARYLAND STATE POLICE TACTICAL SERVICES OPERATIONS & COMMAND BUILDING.GPJ GINT US.GDT 4/14/22

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	SAMPLE DEPTH (ft)	RECOVERY %	BLOW COUNTS (N VALUE)	% < #4 SIEVE	% < #200 SIEVE	▲ SPT N VALUE ▲			
										PL	MC	LL	
225	0.0		TOPSOIL: (4 in)	SS S-1	0.0	72	2-3-3 (6)						
	1.5		SILT: pale yellowish brown, moist, medium stiff, (ML)										
	2.5			SS S-2	2.5	100	3-3-5 (8)						
	4.0		LEAN CLAY: yellowish brown, moist, medium stiff, (CL)										
5	5.0			SS S-3	5.0	100	6-9-12 (21)	99.0	45.5				
	6.5		SILTY SAND: pale orange, medium grained, some clay, moist, medium dense, (SM)										
220	8.5		Dark grayish brown to gray, fine to medium grained, with fine gravel, dense	SS S-4	8.5	83	11-19-23 (42)						
10	10.0												
215	13.5		Yellowish brown, fine to coarse grained, with gravel and rock fragments, very moist	SS S-5	13.5	100	23-26-18 (44)						
15	15.0												
210	18.5		SAND: gray, fine to medium grained, moist to wet, medium dense, (SP)	SS S-6	18.5	56	6-10-15 (25)						
20	20.0		End of boring at 20.0 feet.										

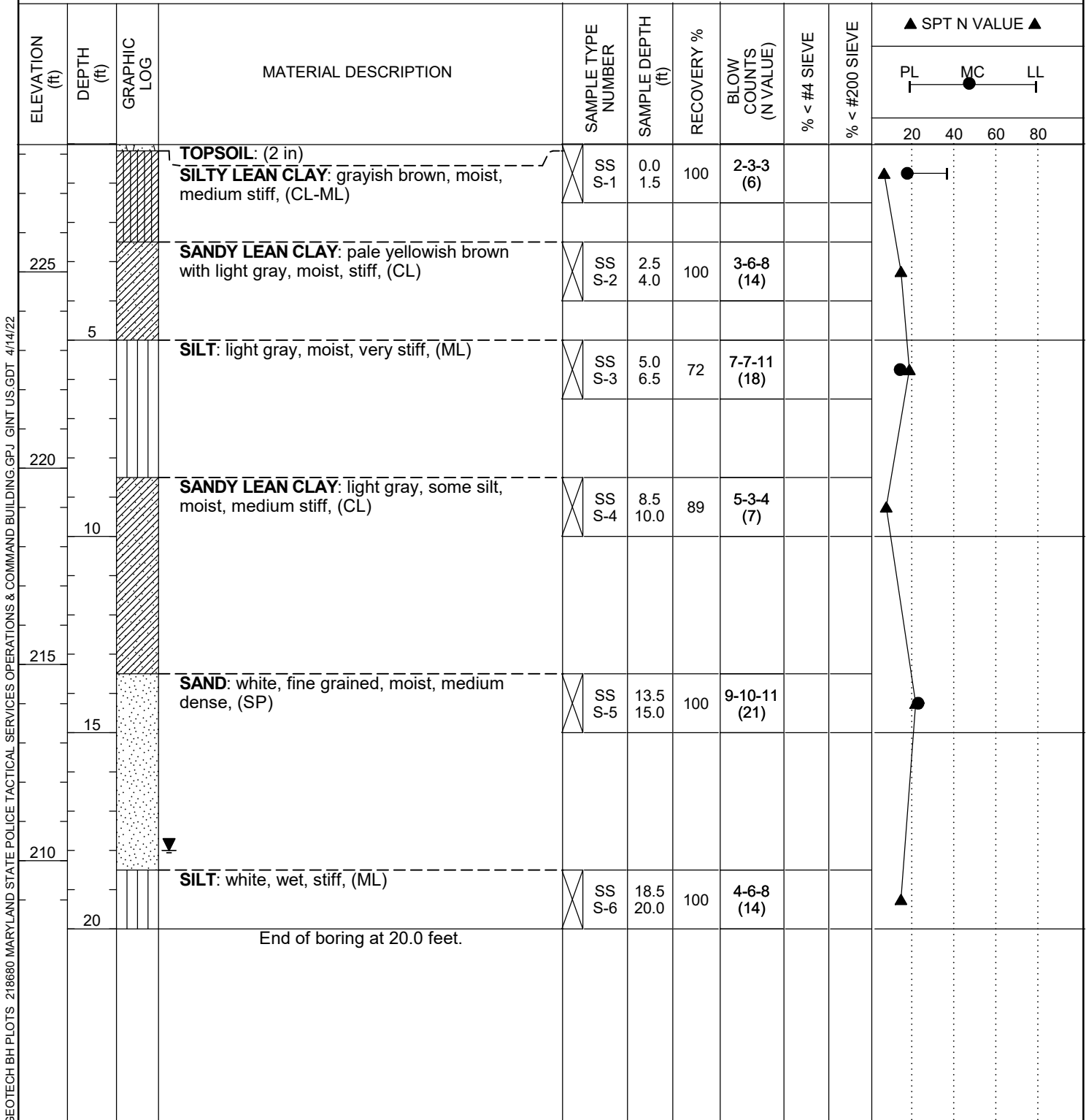
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BORING NUMBER B-5

PAGE 1 OF 1

CLIENT Noelker and Hull Associates, Inc.	PROJECT NAME Maryland State Police TSO & Command Building
PROJECT NUMBER 218680	PROJECT LOCATION Washington Boulevard, Jessup, MD
DATE STARTED 3/25/22	COMPLETED 3/25/22
DRILLING CONTRACTOR Connelly and Associates, Inc.	GROUND ELEVATION 228.26 ft
DRILLING METHOD HSA	HOLE SIZE 3.25" in.
LOGGED BY C. Seong	CHECKED BY J. Cook
NOTES Cave-in = 6.5 ft	GROUND WATER LEVELS:
	▽ AT TIME OF DRILLING 18.0 ft / Elev 210.3 ft
	▼ AT END OF DRILLING 18.0 ft / Elev 210.3 ft
	48hrs AFTER DRILLING None



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BORING NUMBER B-6

PAGE 1 OF 1

CLIENT Noelker and Hull Associates, Inc.	PROJECT NAME Maryland State Police TSO & Command Building
PROJECT NUMBER 218680	PROJECT LOCATION Washington Boulevard, Jessup, MD
DATE STARTED 3/24/22	COMPLETED 3/24/22
DRILLING CONTRACTOR Connelly and Associates, Inc.	GROUND ELEVATION 225.25 ft
DRILLING METHOD HSA	HOLE SIZE 3.25" in.
LOGGED BY C. Seong	CHECKED BY J. Cook
NOTES Cave-in = 12 ft	GROUND WATER LEVELS:
	▽ AT TIME OF DRILLING 18.5 ft / Elev 206.8 ft
	▼ AT END OF DRILLING 19.5 ft / Elev 205.8 ft
	AFTER DRILLING None, Backfilled upon completion

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	SAMPLE DEPTH (ft)	RECOVERY %	BLOW COUNTS (N VALUE)	% < #4 SIEVE	% < #200 SIEVE	▲ SPT N VALUE ▲			
										PL	MC	LL	
										20	40	60	80
			TOPSOIL: (5 in)										
			SAND: light brown and gray, trace clay, moist, loose, (SW)	SS S-1	0.0 1.5	89	2-2-10 (12)						
				SS S-2	2.5 4.0	100	3-2-8 (10)						
220	5		Medium dense	SS S-3	5.0 6.5	100	5-5-6 (11)						
				SS S-4	8.5 10.0	100	10-7-9 (16)						
215	10			SS S-5	13.5 15.0	83	17-18-11 (29)						
			With gravel, trace clay, very moist	SS S-6	18.5 20.0	100	13-18-26 (44)						
210	15												
			Dense										
20	20		End of boring at 20.0 feet.										

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BORING NUMBER P-1

PAGE 1 OF 1

CLIENT Noelker and Hull Associates, Inc. **PROJECT NAME** Maryland State Police TSO & Command Building
PROJECT NUMBER 218680 **PROJECT LOCATION** Washington Boulevard, Jessup, MD
DATE STARTED 3/24/22 **COMPLETED** 3/24/22 **GROUND ELEVATION** 228.92 ft **HOLE SIZE** 3.25" in.
DRILLING CONTRACTOR Connelly and Associates, Inc. **GROUND WATER LEVELS:**
DRILLING METHOD HSA **AT TIME OF DRILLING** None
LOGGED BY C. Seong **CHECKED BY** J. Cook **AT END OF DRILLING** None
NOTES Offset 31 ft N, Cave-in = 4.0 ft **AFTER DRILLING** None, Backfilled upon completion

GEOTECH|BH PLOTS 218680 MARYLAND STATE POLICE TACTICAL SERVICES OPERATIONS & COMMAND BUILDING.GPJ GINT US.GDT 4/14/22

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	SAMPLE DEPTH (ft)	RECOVERY %	BLOW COUNTS (N VALUE)	% < #4 SIEVE	% < #200 SIEVE	▲ SPT N VALUE ▲	
										PL	MC
			TOPSOIL: (6 in)								
			SILT: pale yellowish brown, with clay, moist, medium stiff, (ML)	SS S-1	0.0 1.5	100	3-3-5 (8)				
			Stiff	SS S-2	2.5 4.0	100	6-7-8 (15)				
225	5		SANDY SILT: pale yellowish brown with white, moist, stiff, (ML)	SS S-3	5.0 6.5	100	6-6-7 (13)				
220	10		SILTY SAND: light gray, medium to coarse grained, with fine gravel, moist, loose, (SM)	SS S-4	8.5 10.0	100	5-4-6 (10)				
			End of boring at 10.0 feet.								

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BORING NUMBER P-2

PAGE 1 OF 1

CLIENT Noelker and Hull Associates, Inc.	PROJECT NAME Maryland State Police TSO & Command Building
PROJECT NUMBER 218680	PROJECT LOCATION Washington Boulevard, Jessup, MD
DATE STARTED 3/25/22	COMPLETED 3/25/22
DRILLING CONTRACTOR Connelly and Associates, Inc.	GROUND ELEVATION 225.09 ft
DRILLING METHOD HSA	HOLE SIZE 3.25" in.
LOGGED BY C. Seong	CHECKED BY J. Cook
NOTES Cave-in = 6 ft	GROUND WATER LEVELS:
	AT TIME OF DRILLING None
	AT END OF DRILLING None
	AFTER DRILLING None, Backfilled upon completion

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	SAMPLE DEPTH (ft)	RECOVERY %	BLOW COUNTS (N VALUE)	% < #4 SIEVE	% < #200 SIEVE	▲ SPT N VALUE ▲		
										PL	MC	LL
			TOPSOIL: (6 in)									
			SILT: grayish brown, moist, medium stiff, (ML)	SS S-1	0.0 1.5	100	WOH-3-5 (8)					
			CLAYEY SAND: brown, moist, loose, (SC)	SS S-2	2.5 4.0	56	4-4-3 (7)	96.9	40.2			
220	5		Loose	SS S-3	5.0 6.5	33	3-4-5 (9)					
			Reddish brown, medium dense	SS S-4	8.5 10.0	22	5-6-9 (15)					
			End of boring at 10.0 feet.									

GEOTECH BH PLOTS 218680 MARYLAND STATE POLICE TACTICAL SERVICES OPERATIONS & COMMAND BUILDING.GPJ GINT US.GDT 4/21/22

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BORING NUMBER P-3

PAGE 1 OF 1

CLIENT <u>Noelker and Hull Associates, Inc.</u>	PROJECT NAME <u>Maryland State Police TSO & Command Building</u>
PROJECT NUMBER <u>218680</u>	PROJECT LOCATION <u>Washington Boulevard, Jessup, MD</u>
DATE STARTED <u>3/25/22</u> COMPLETED <u>3/25/22</u>	GROUND ELEVATION <u>212.22 ft</u> HOLE SIZE <u>3.25" in.</u>
DRILLING CONTRACTOR <u>Connelly and Associates, Inc.</u>	GROUND WATER LEVELS:
DRILLING METHOD <u>HSA</u>	AT TIME OF DRILLING <u>None</u>
LOGGED BY <u>C. Seong</u> CHECKED BY <u>J. Cook</u>	AT END OF DRILLING <u>None</u>
NOTES <u>Cave-in = 6 ft</u>	AFTER DRILLING <u>None, Backfilled upon completion</u>

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	SAMPLE DEPTH (ft)	RECOVERY %	BLOW COUNTS (N VALUE)	% < #4 SIEVE	% < #200 SIEVE	▲ SPT N VALUE ▲		
										PL	MC	LL
210 5 205 10			TOPSOIL: very loose, (+18 in)	SS S-1	0.0 1.5	22	1-WOH-1 (1)			▲	●	
			SILTY SAND: white, medium to coarse grained, very moist, loose, (SM)	SS S-2	2.5 4.0	83	3-3-4 (7)			▲		
			Orangish brown, fine to medium grained, medium dense	SS S-3	5.0 6.5	89	4-6-7 (13)			●		
				SS S-4	8.5 10.0	89	4-5-6 (11)			▲		
			End of boring at 10.0 feet.									

GEOTECH\BH PLOTS 218680 MARYLAND STATE POLICE TACTICAL SERVICES OPERATIONS & COMMAND BUILDING.GPJ GINT US.GDT 4/14/22

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BORING NUMBER P-4

PAGE 1 OF 1

CLIENT Noelker and Hull Associates, Inc.

PROJECT NAME Maryland State Police TSO & Command Building

PROJECT NUMBER 218680

PROJECT LOCATION Washington Boulevard, Jessup, MD

DATE STARTED 3/25/22 COMPLETED 3/25/22

GROUND ELEVATION 211.99 ft HOLE SIZE 3.25" in.

DRILLING CONTRACTOR Connelly and Associates, Inc.

GROUND WATER LEVELS:

DRILLING METHOD HSA

AT TIME OF DRILLING None

LOGGED BY C. Seong CHECKED BY J. Cook

AT END OF DRILLING None

NOTES Cave-in = 8 ft

AFTER DRILLING None, Backfilled upon completion

GEOTECH\BH PLOTS 218680 MARYLAND STATE POLICE TACTICAL SERVICES OPERATIONS & COMMAND BUILDING.GPJ GINT US.GDT 4/14/22

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	SAMPLE DEPTH (ft)	RECOVERY %	BLOW COUNTS (N VALUE)	% < #4 SIEVE	% < #200 SIEVE	▲ SPT N VALUE ▲		
										PL	MC	LL
210	0.0		TOPSOIL: (4 in)	SS S-1	0.0	22	WOH-2-2 (4)	100.0	72.5			
	1.5		SANDY SILT: yellowish brown, moist, soft, (ML)									
	2.5		SANDY LEAN CLAY: reddish brown, moist, stiff, (CL)	SS S-2	2.5	89	5-6-7 (13)					
5	4.0		Very stiff									
	5.0			SS S-3	5.0	89	7-8-11 (19)					
205	6.5											
	8.5		SANDY SILT: white, moist, stiff, (ML)	SS S-4	8.5	78	8-5-10 (15)					
10	10.0											
200												
	13.5		SAND: white, fine to coarse grained, moist, dense, (SW)	SS S-5	13.5	83	12-23-21 (44)					
15	15.0		End of boring at 15.0 feet.									

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BORING NUMBER SWM-1

PAGE 1 OF 1

CLIENT Noelker and Hull Associates, Inc.	PROJECT NAME Maryland State Police TSO & Command Building
PROJECT NUMBER 218680	PROJECT LOCATION Washington Boulevard, Jessup, MD
DATE STARTED 3/24/22	COMPLETED 3/24/22
DRILLING CONTRACTOR Connelly and Associates, Inc.	GROUND ELEVATION 227.47 ft
DRILLING METHOD HSA	HOLE SIZE 3.25" in.
LOGGED BY C. Seong	CHECKED BY J. Cook
NOTES Cave-in = 4 ft	GROUND WATER LEVELS:
	AT TIME OF DRILLING None
	AT END OF DRILLING None
	24hrs AFTER DRILLING None

GINT US.GDT 4/14/22
GEOTECH\BH PLOTS 218680 MARYLAND STATE POLICE TACTICAL SERVICES OPERATIONS & COMMAND BUILDING.GPJ

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	SAMPLE DEPTH (ft)	RECOVERY %	BLOW COUNTS (N VALUE)	% < #4 SIEVE	% < #200 SIEVE	▲ SPT N VALUE ▲		
										PL	MC	LL
			TOPSOIL: (2 in)									
			FILL: black sand, with asphalt, with gravel, moist, medium dense	SS S-1	0.0 1.5	39	8-7-7 (14)					
225			SILT: yellowish brown, some sand, moist, stiff, (ML)	SS S-2	2.5 4.0	100	5-4-8 (12)					
5			SILTY LEAN CLAY: pale yellowish brown with light gray, moist, stiff, (CL-ML)	SS S-3	5.0 6.5	100	5-5-8 (13)					
220			SILTY SAND: yellowish brown, fine to coarse grained, with gravel with rock fragments, very moist, medium dense, (SM)	SS S-4	8.5 10.0	83	5-10-16 (26)					
10			End of boring at 10.0 feet.									

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BORING NUMBER SWM-2

PAGE 1 OF 1

CLIENT <u>Noelker and Hull Associates, Inc.</u>	PROJECT NAME <u>Maryland State Police TSO & Command Building</u>
PROJECT NUMBER <u>218680</u>	PROJECT LOCATION <u>Washington Boulevard, Jessup, MD</u>
DATE STARTED <u>3/24/22</u> COMPLETED <u>3/24/22</u>	GROUND ELEVATION <u>224.45 ft</u> HOLE SIZE <u>3.25" in.</u>
DRILLING CONTRACTOR <u>Connelly and Associates, Inc.</u>	GROUND WATER LEVELS:
DRILLING METHOD <u>HSA</u>	AT TIME OF DRILLING <u>None</u>
LOGGED BY <u>C. Seong</u> CHECKED BY <u>J. Cook</u>	AT END OF DRILLING <u>None</u>
NOTES <u>Cave-in = 4 ft</u>	24hrs AFTER DRILLING <u>None</u>

GEOTECH\BH PLOTS 218680 MARYLAND STATE POLICE TACTICAL SERVICES OPERATIONS & COMMAND BUILDING.GPJ GINT US.GDT 4/14/22

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	SAMPLE DEPTH (ft)	RECOVERY %	BLOW COUNTS (N VALUE)	% < #4 SIEVE	% < #200 SIEVE	▲ SPT N VALUE ▲			
										PL	MC	LL	
										20	40	60	80
			TOPSOIL: (6 in)	SS S-1	0.0	22	WOH-WOH-WOH (0)						
			LEAN CLAY: yellowish brown, moist, very soft, (CL)		1.5								
			SILT: pale yellowish brown with light gray, with clay, moist, hard, (ML)	SS S-2	2.5	100	13-14-17 (31)						
220	5		CLAYEY SAND: reddish brown, fine to medium grained, moist, medium dense, (SC)	SS S-3	5.0	78	7-10-8 (18)						
			SILTY SAND: yellowish brown, fine to coarse grained, with gravel and rock fragments, very moist, dense, (SM)	SS S-4	8.5	89	15-24-23 (47)						
215	10		End of boring at 10.0 feet.		10.0								

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BORING NUMBER SWM-3

PAGE 1 OF 1

CLIENT Noelker and Hull Associates, Inc. PROJECT NAME Maryland State Police TSO & Command Building
 PROJECT NUMBER 218680 PROJECT LOCATION Washington Boulevard, Jessup, MD
 DATE STARTED 3/25/22 COMPLETED 3/25/22 GROUND ELEVATION 222.09 ft HOLE SIZE 3.25" in.
 DRILLING CONTRACTOR Connelly and Associates, Inc. GROUND WATER LEVELS:
 DRILLING METHOD HSA AT TIME OF DRILLING None
 LOGGED BY C. Seong CHECKED BY J. Cook AT END OF DRILLING None
 NOTES Cave-in = 6 ft, Installed Infiltration Pipe at 2 ft Depth 24hrs AFTER DRILLING None

GEOTECH\BH PLOTS 218680 MARYLAND STATE POLICE TACTICAL SERVICES OPERATIONS & COMMAND BUILDING.GPJ GINT US.GDT 4/14/22

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	SAMPLE DEPTH (ft)	RECOVERY %	BLOW COUNTS (N VALUE)	% < #4 SIEVE	% < #200 SIEVE	▲ SPT N VALUE ▲		
										PL	MC	LL
			TOPSOIL: (3 in)									
			CLAYEY SAND: brown, fine to coarse grained, moist, loose, (SC)	SS S-1	0.0 1.5	67	2-5-4 (9)					
220			SILTY SAND: brown, fine to coarse grained, some silt, moist, very loose, (SM)	SS S-2	2.5 4.0	56	2-1-3 (4)	97.6	38.5			
5			Loose	SS S-3	5.0 6.5	33	4-4-1 (5)					
215			Very loose	SS S-4	8.5 10.0	67	2-2-2 (4)					
10			End of boring at 10.0 feet.									

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BORING NUMBER SWM-4

PAGE 1 OF 1

CLIENT Noelker and Hull Associates, Inc.	PROJECT NAME Maryland State Police TSO & Command Building
PROJECT NUMBER 218680	PROJECT LOCATION Washington Boulevard, Jessup, MD
DATE STARTED 3/25/22	COMPLETED 3/25/22
DRILLING CONTRACTOR Connelly and Associates, Inc.	GROUND ELEVATION 208.82 ft
DRILLING METHOD HSA	HOLE SIZE 3.25" in.
LOGGED BY C. Seong	CHECKED BY J. Cook
NOTES Cave-in = 4 ft, Installed Infiltration Pipe at 2 ft Depth	GROUND WATER LEVELS:
	AT TIME OF DRILLING None
	AT END OF DRILLING None
	24hrs AFTER DRILLING None

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	SAMPLE DEPTH (ft)	RECOVERY %	BLOW COUNTS (N VALUE)	% < #4 SIEVE	% < #200 SIEVE	▲ SPT N VALUE ▲		
										PL	MC	LL
			TOPSOIL: (6 in)									
			CLAYEY SAND: dark brown, very moist, very loose, (SC)	SS S-1	0.0 1.5	22	1-1-1 (2)					
205	5		SILTY LEAN CLAY: yellowish brown with white, moist, medium stiff, (CL-ML)	SS S-2	2.5 4.0	89	WOH-3-4 (7)	100.0	94			
			Stiff									
				SS S-3	5.0 6.5	67	4-6-7 (13)					
200	10		SANDY SILT: pale brown, moist, stiff, (ML)	SS S-4	8.5 10.0	56	5-6-5 (11)					
			End of boring at 10.0 feet.									

GEOTECH|BH PLOTS 218680 MARYLAND STATE POLICE TACTICAL SERVICES OPERATIONS & COMMAND BUILDING.GPJ GINT US.GDT 4/14/22

APPENDIX C
LABORATORY TEST RESULTS



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SUMMARY OF LABORATORY RESULTS

PAGE 1 OF 2

CLIENT Noelker and Hull Associates, Inc.

PROJECT NAME Maryland State Police TSO & Command Building

PROJECT NUMBER 218680

PROJECT LOCATION Washington Boulevard, Jessup, MD

Borehole	Depth (ft)	Classification	Liquid Limit	Plastic Limit	Plasticity Index	Moisture Content (%)	% < #4 Sieve	% < #200 Sieve	Other Tests
B-1	0.0					13.6			
B-1	5.0	CL	35	18	17	13.9			
B-1	13.5					8.9			
B-2	0.0					23.4			
B-2	5.0					22.7			
B-2	8.5					14.2			
B-2	13.5	GM				20.3	54.4	24.2	
B-2	18.5					38.7			
B-3	2.5	CL	31	18	13	20.7			
B-3	5.0					14.2			
B-3	8.5					7.3			
B-3	13.5					16.4			
B-3	18.5					43.8			
B-4	0.0					14			
B-4	5.0	SM				12.1	99	45.5	
B-4	8.5					9.3			
B-4	13.5					4.6			
B-4	18.5					22.8			
B-5	0.0	CL	36	17	19	17.1			
B-5	5.0					13.7			
B-5	13.5					22.3			
B-6	2.5					11.1			
B-6	8.5					17.6			
B-6	18.5					20.5			
P-1	0.0					24.4			
P-1	5.0					16.8			
P-2	2.5	SC				21.1	96.9	40.2	
P-2	8.5					21.1			
P-3	0.0					19.6			
P-3	5.0					16.3			
P-4	0.0	ML				14.2	100	72.5	
P-4	5.0					11.6			
P-4	8.5					10.4			
P-4	13.5					2.3			
SWM-1	0.0					1.9			
SWM-1	2.5					14.7			
SWM-1	5.0					19.5			
SWM-1	8.5					7.7			
SWM-2	0.0	CL	35	21	14	24.7			
SWM-2	2.5					15.5			
SWM-2	5.0					12.5			
SWM-2	8.5					5.7			

(V) = Visual Classification USCS

TEST SUMMARY 218680 MARYLAND STATE POLICE TACTICAL SERVICES OPERATIONS & COMMAND BUILDING.GPJ GINT US.GDT 4/13/22

CLIENT Noelker and Hull Associates, Inc.

PROJECT NAME Maryland State Police TSO & Command Building

PROJECT NUMBER 218680

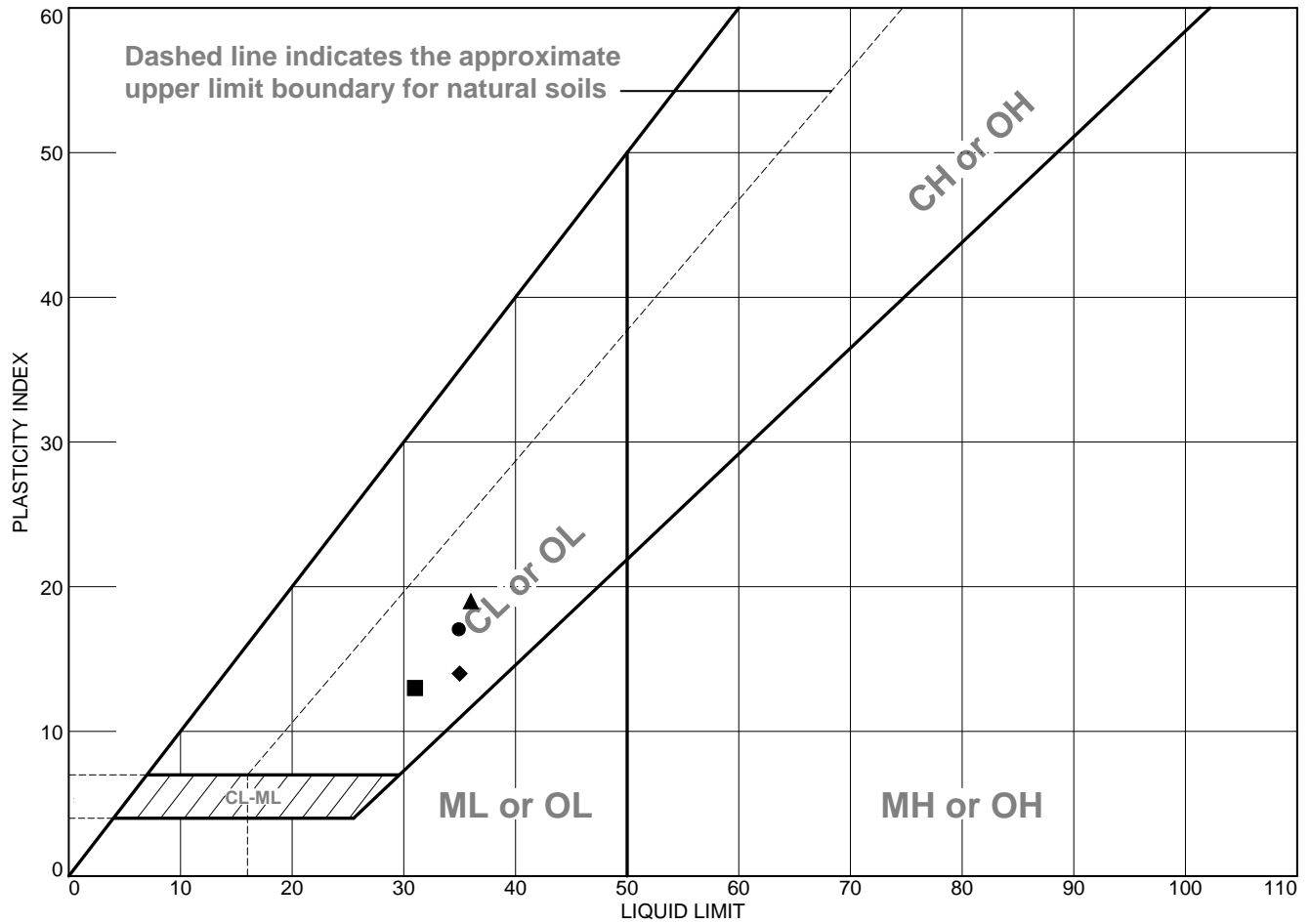
PROJECT LOCATION Washington Boulevard, Jessup, MD

Borehole	Depth (ft)	Classification	Liquid Limit	Plastic Limit	Plasticity Index	Moisture Content (%)	% < #4 Sieve	% < #200 Sieve	Other Tests
SWM-3	0.0					9.7			
SWM-3	2.5	SM				9.7	97.6	38.5	
SWM-3	5.0					16.7			
SWM-3	8.5					12.7			
SWM-4	0.0					29			
SWM-4	2.5					20.3	100	94	
SWM-4	5.0					12.5			
SWM-4	8.5					21.1			

TEST SUMMARY 218680 MARYLAND STATE POLICE TACTICAL SERVICES OPERATIONS & COMMAND BUILDING.GPJ GINT US.GDT 4/13/22

(V) = Visual Classification USCS

LIQUID AND PLASTIC LIMITS TEST REPORT



MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	35	18	17			
■	31	18	13			
▲	36	17	19			
◆	35	21	14			

Project No. 218680 **Client:** Noelker and Hull Associates, Inc.
Project: Maryland State Police Tactical Services

● **Location:** B-01, S-03 **Depth:** 5.0' **Sample Number:** B-01, S-03
■ **Location:** B-03, S-02 **Depth:** 2.5' **Sample Number:** B-03, S-02
▲ **Location:** B-05, S-01 **Depth:** 0.0' **Sample Number:** B-05, S-01
◆ **Location:** SWM-02, S-01 **Depth:** 0.0' **Sample Number:** SWM-02, S-01

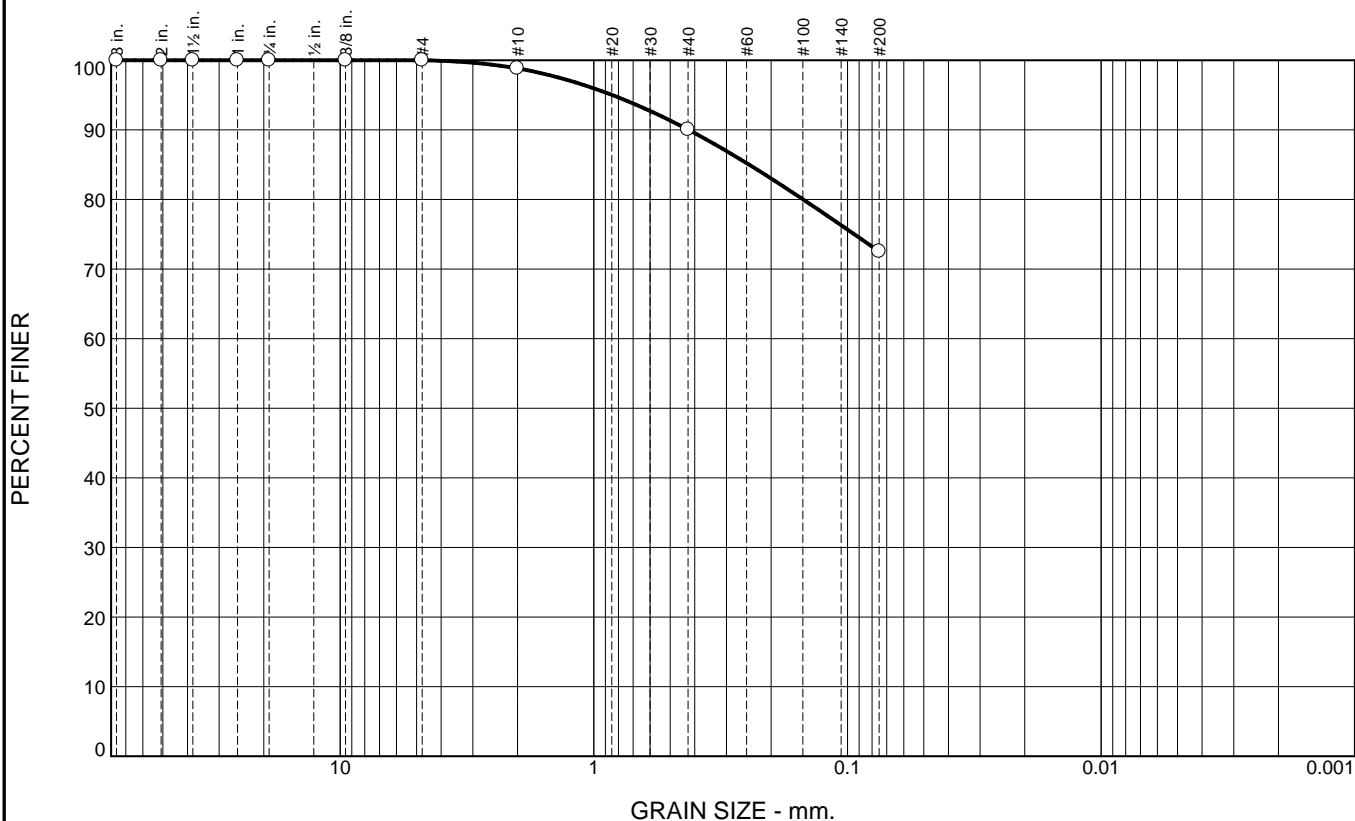
SPECIALIZED ENGINEERING

Frederick, Maryland

Remarks:

Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	1.2	8.8	17.5	72.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
2 in.	100.0		
1 1/2 in.	100.0		
1 in.	100.0		
3/4 in.	100.0		
3/8 in.	100.0		
#4	100.0		
#10	98.8		
#40	90.0		
#200	72.5		

Material Description

PL= **Atterberg Limits** PI=

LL=

USCS= **Classification** AASHTO=

Remarks

* (no specification provided)

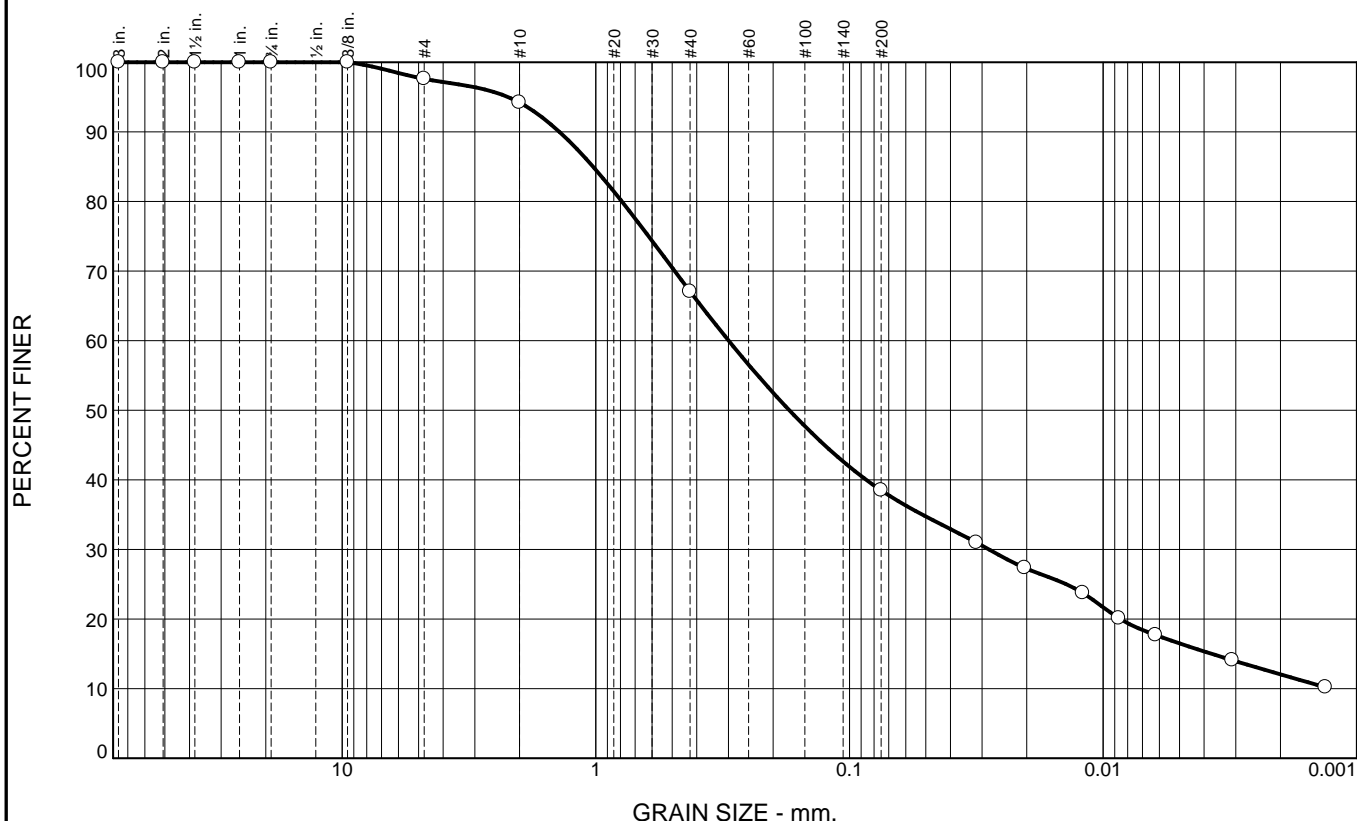
Location: P-04, S-01 **Depth:** 0.0'

Sample Number: P-04, S-01

Date:

<p>SPECIALIZED ENGINEERING</p> <p>Frederick, Maryland</p>	<p>Client: Noelker and Hull Associates, Inc.</p> <p>Project: Maryland State Police Tactical Services</p> <p>Project No: 218680</p>
<p>Figure</p>	

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.4	3.4	27.1	28.6	22.0	16.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X-NO)
3 in.	100.0		
2 in.	100.0		
1 1/2 in.	100.0		
1 in.	100.0		
3/4 in.	100.0		
3/8 in.	100.0		
#4	97.6		
#10	94.2		
#40	67.1		
#200	38.5		

Material Description

PL= **Atterberg Limits** PI=

LL=

USCS= **Classification** AASHTO=

Remarks

* (no specification provided)

Location: SWM-03, S-02
Sample Number: SWM-03, S-02

Depth: 2.5'

Date:

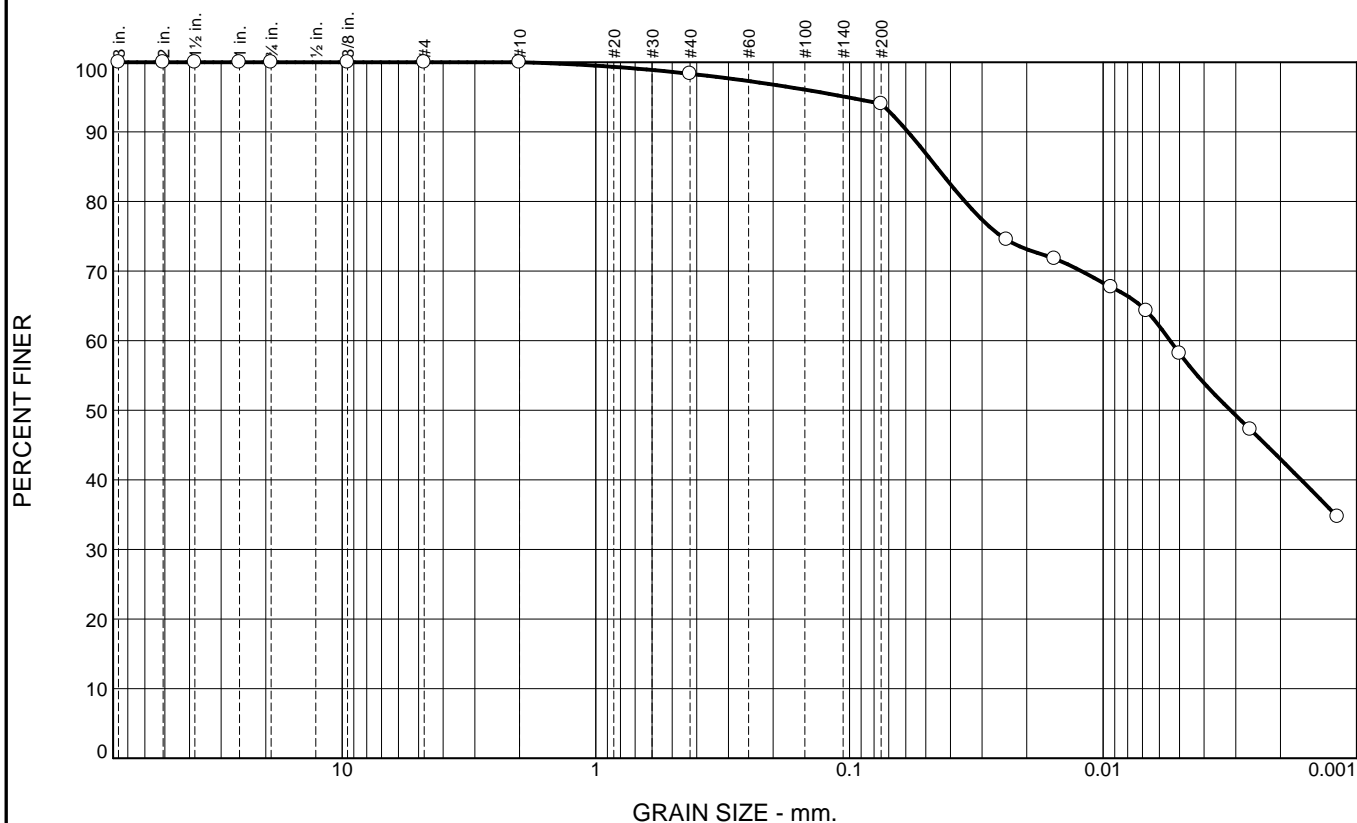
**SPECIALIZED
ENGINEERING
Frederick, Maryland**

Client: Noelker and Hull Associates, Inc.
Project: Maryland State Police Tactical Services

Project No: 218680

Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.7	4.3	35.8	58.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X-NO)
3 in.	100.0		
2 in.	100.0		
1 1/2 in.	100.0		
1 in.	100.0		
3/4 in.	100.0		
3/8 in.	100.0		
#4	100.0		
#10	100.0		
#40	98.3		
#200	94.0		

Material Description

PL= **Atterberg Limits** PI=

LL=

USCS= **Classification** AASHTO=

Remarks

* (no specification provided)

Location: SWM-04, S-02
Sample Number: SWM-04, S-02

Depth: 2.5'

Date:

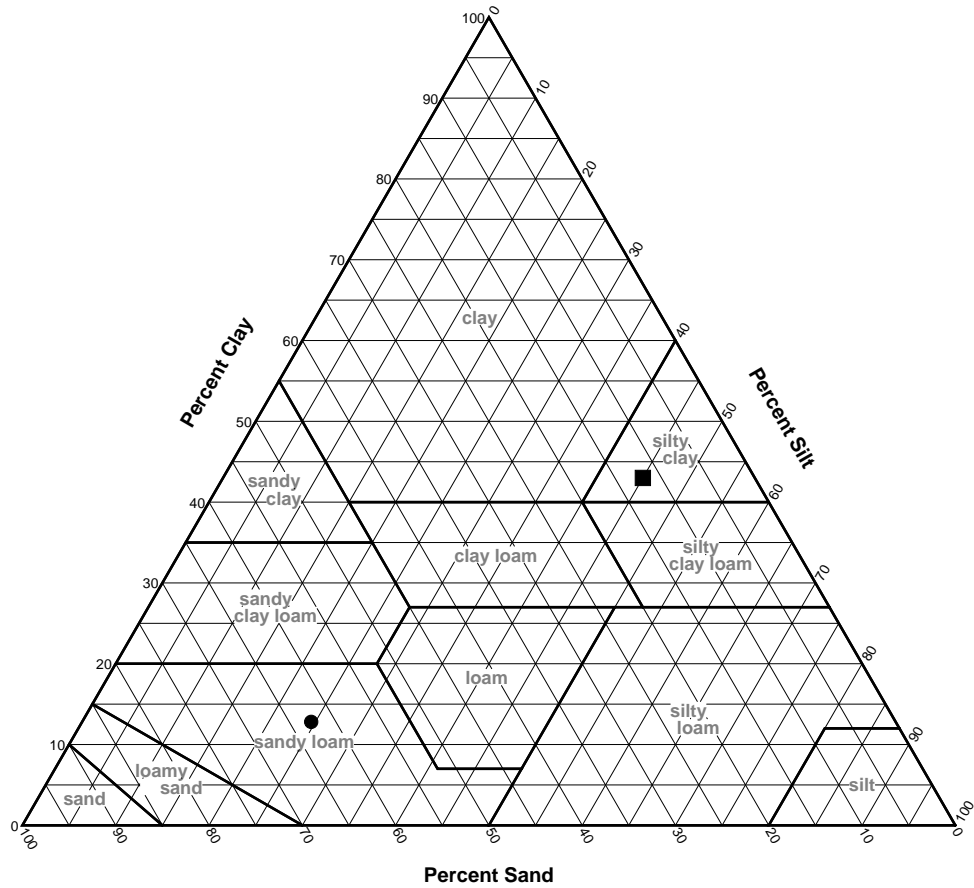
**SPECIALIZED
ENGINEERING
Frederick, Maryland**

Client: Noelker and Hull Associates, Inc.
Project: Maryland State Police Tactical Services

Project No: 218680

Figure

USDA Soil Classification



SOIL DATA							
	Source	Sample No.	Depth	Percentages From Material Passing a #10 Sieve			Classification
				Sand	Silt	Clay	
●		SWM-03, S-02	2.5'	62.6	24.6	12.7	Sandy loam
■		SWM-04, S-02	2.5'	12.0	45.0	43.0	Silty clay

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Phased construction.
4. Work under Owner's separate contracts.
5. Owner-furnished/Contractor-installed (OFICI) products.
6. Contractor's use of site and premises.
7. Coordination with occupants.
8. Work restrictions.
9. Specification and Drawing conventions.
10. Miscellaneous provisions.

- B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.
2. Section 017300 "Execution" for coordination of Owner-installed products.

1.3 DEFINITIONS

- A. Work Package: A group of specifications, drawings, and schedules prepared by the design team to describe a portion of the Project Work for pricing, permitting, and construction.

1.4 PROJECT INFORMATION

- A. Project Identification: Maryland State Police Tactical Administration Center

1. Project Location: 7777 Washington Boulevard, Jessup, Maryland

- B. Owner: Maryland State Police

1. Owner's Representative: Hamid Hekmatian, Capital Projects Manager, Maryland Department of General Services, 410-767-4903, hamid.hekmatian@maryland.gov

- C. Architect: Noelker and Hull Architects, 6 N. East St., Suite 300, Frederick, MD 21701
 - 1. Architect's Representative: Robert M. Asbury, AIA, Principal, 301-662-8611, rasbury@noelkerhull.com
- D. Architect's Consultants: Architect has retained the following design professionals, who have prepared designated portions of the Contract Documents:
 - 1. Acoustical: Acoustical Design Collaborative 410.821.5930
 - 2. Structural: Advanced Consulting Engineers, PA (ACEPA) 301.258.8884
 - 3. Environmental: A. Morton Thomas (AMT) 301.881.2545
 - 4. LEED: Lorax Partnerships, LLC (previously Doo Consulting) 443.449.6319
 - 5. Cost Estimating: KUMI 202.684.8858
 - 6. Civil: NMP Engineering 410.77139808
 - 7. Geotechnical: Specialized Engineering 410.768.4803
 - 8. MEP: Weigand Associates 301.540.9060
 - 9. Telecommunications: Wright Engineering 410.887.6297

1.5 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following:
 - 1. Construction of a new facility for the Maryland State Police Special Operations Division and the Maryland State Fire Marshal Bomb Squad, as well as an incident command facility and training area. The building is an approximately 21,000 square foot one and two-story building of IBC 2B construction with a metal frame, business occupancy. It will be attached by a pedestrian passage to the existing Tactical Services garage. Work includes building construction, site and utility work, and other Work indicated in the Contract Documents.
 - 2. The work includes the construction of an explosives storage area, to be completed after that portion of the site is vacated by construction activities and staging. This contract includes concrete pads, fencing and access roadways in preparation for that work.
 - 3. The explosives containment units will be furnished and installed under a separate contract upon completion of the work of this contract.
- B. Type of Contract:
 - 1. Project will be constructed under a single prime contract.

1.6 WORK PERFORMED BY OWNER

- A. Cooperate fully with Owner, so work may be carried out smoothly, without interfering with or delaying Work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.
- B. Concurrent Work: Owner will perform the following construction operations at Project site. Those operations will be conducted simultaneously with Work under this Contract.
 - 1. Installation of information technology and audio-visual equipment.
- C. Work with Separate Contractors: Cooperate fully with Owner's separate contractors, so work on those contracts may be carried out smoothly, without interfering with or delaying Work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under Owner's separate contracts.

1.7 OWNER-FURNISHED/CONTRACTOR-INSTALLED (OFCI) PRODUCTS

- A. Owner's Responsibilities: Owner will furnish products indicated and perform the following, as applicable:
 - 1. Provide to Contractor Owner-reviewed Product Data, Shop Drawings, and Samples.
 - 2. Provide for delivery of Owner-furnished products to Project site.
 - 3. Upon delivery, inspect, with Contractor present, delivered items.
 - a. If Owner-furnished products are damaged, defective, or missing, arrange for replacement.
 - 4. Obtain manufacturer's inspections, service, and warranties.
 - 5. Inform Contractor of earliest available delivery date for Owner-furnished products.
- B. Contractor's Responsibilities: The Work includes the following, as applicable:
 - 1. Designate delivery dates of Owner-furnished products in Contractor's construction schedule, utilizing Owner-furnished earliest available delivery dates.
 - 2. Review Owner-reviewed Product Data, Shop Drawings, and Samples, noting discrepancies and other issues in providing for Owner-furnished products in the Work.
 - 3. Receive, unload, handle, store, protect, and install Owner-furnished products.
 - 4. Make building services connections for Owner-furnished products.
 - 5. Protect Owner-furnished products from damage during storage, handling, and installation and prior to Substantial Completion.
 - 6. Repair or replace Owner-furnished products damaged following receipt.
- C. Owner-Furnished/Contractor-Installed (OFCI) Products:
 - 1. Appliances.

1.8 OWNER-FURNISHED/OWNER-INSTALLED (OFOI) PRODUCTS

- A. The Owner will furnish and install products indicated.
- B. Owner-Furnished/Owner-Installed (OFOI) Products:
 - 1. Audio-visual and information technology products

1.9 CONTRACTOR'S USE OF SITE AND PREMISES

- A. Restricted Use of Site: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.
- B. Limits on Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
 - 1. Driveways, Walkways and Entrances: Keep driveways loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- C. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.10 COORDINATION WITH OCCUPANTS

- A. Full Owner Occupancy: Owner will occupy Project site and existing adjacent building(s) during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
 - 2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.

1.11 WORK RESTRICTIONS

- A. Comply with restrictions on construction operations.

1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.
- B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging for temporary utility services according to requirements indicated:
 1. Notify Owner not less than two days in advance of proposed utility interruptions.
 2. Obtain Owner's written permission before proceeding with utility interruptions.
- C. Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Owner occupancy with Owner.
 1. Notify Owner not less than two days in advance of proposed disruptive operations.
 2. Obtain Owner's written permission before proceeding with disruptive operations.
- D. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor-air intakes.
- E. Smoking and Controlled Substance Restrictions: Use of tobacco products, alcoholic beverages, and other controlled substances on Owner's property is not permitted.
- F. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.
- G. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.
 1. Maintain list of approved screened personnel with Owner's representative.

1.12 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 2. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
 3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
 4. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

- B. Division 00 Contracting Requirements: General provisions of the Contract, including General and Supplementary Conditions, apply to all Sections of the Specifications.
- C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- D. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 - 2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings and published as part of the U.S. National CAD Standard.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012100 - ALLOWANCES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements governing allowances.
- B. Types of allowances include the following:
 - 1. Lump-sum allowances.
 - 2. Contingency allowances.
 - 3. Quantity allowances.
- C. Related Requirements:
 - 1. Section 012200 "Unit Prices" for procedures for using unit prices, including adjustment of quantity allowances when applicable.
 - 2. Section 012600 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.
 - 3. Section 014000 "Quality Requirements" for procedures governing the use of allowances for field testing by an independent testing agency.

1.2 DEFINITIONS

- A. Allowance: A quantity of work or dollar amount included in the Contract, established in lieu of additional requirements, used to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.

1.3 SELECTION AND PURCHASE

- A. At the earliest practical date after award of the Contract, advise Architect of the date when final selection, or purchase and delivery, of each product or system described by an allowance must be completed by the Owner to avoid delaying the Work.
- B. Architect Responsibilities:
 - 1. Select products in consultation with Owner and transmit decision to Contractor.
 - 2. The Architect will prepare an Architectural Supplemental Instruction (ASI) directing the Contractor to perform the work identified under the appropriate Allowance number and title.
 - 3. Review and comment on all submitted product submittals prior to purchase and installation.
- C. Contractor Responsibilities:
 - 1. Obtain proposals from suppliers and installers and offer recommendations.

2. On notification of selection execute purchase agreement with designated supplier and installer.
3. Arrange for and process shop drawings, product data, and samples. Arrange for delivery.
4. Coordinate installation of allowance items with related building spaces, materials, equipment, and scheduling.
5. Notify suppliers or subcontractors of required delivery dates and installation periods.
6. Install and finish products in accordance with requirements of referenced specification sections.

D. Purchase products and systems selected by Architect from the designated supplier.

1.4 ACTION SUBMITTALS

- A. Submit proposals for purchase of products or systems included in allowances in the form specified for Change Orders.

1.5 INFORMATIONAL SUBMITTALS

- A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.6 LUMP-SUM ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include taxes, freight, and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.

1.7 CONTINGENCY ALLOWANCES

- A. Use the contingency allowance only as directed by Architect for Owner's purposes and only by Change Orders that indicate amounts to be charged to the allowance.
- B. Contractor's overhead, profit, and related costs for products and equipment ordered by Owner under the contingency allowance are included in the allowance and are not part of the Contract Sum. These costs include delivery, installation, taxes, insurance, equipment rental, and similar costs.

- C. Change Orders authorizing use of funds from the contingency allowance will include Contractor's related costs and reasonable overhead and profit.
- D. At Project closeout, credit unused amounts remaining in the contingency allowance to Owner by Change Order.

1.8 QUANTITY ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include taxes, freight, and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.

1.9 ADJUSTMENT OF ALLOWANCES

- A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, required maintenance materials, and similar margins.
 - 1. Include installation costs in purchase amount only where indicated as part of the allowance.
 - 2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other markups.
 - 3. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
- B. Submit claims for increased costs due to a change in the scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.
 - 1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of Work has changed from what could have been foreseen from information in the Contract Documents.
 - 2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.3 SCHEDULE OF ALLOWANCES

- A. Allowance No. 1: Lump-Sum Allowance: Include the sum of \$1000.00 for exterior dimensional numbers, and for vinyl applique door signage.
 - 1. This allowance includes material, receiving, handling, and installation costs, and Contractor overhead and profit.
- B. Allowance No. 2: Lump-Sum Allowance: Include the sum of \$2,500.00 for a dedication plaque.
 - 1. This allowance includes material, receiving, handling, and installation costs, and Contractor overhead and profit.
- C. Allowance No. 3: Contingency Allowance: Include a contingency allowance of \$10,000.00 for slab moisture control, as warranted by testing of slab humidity.
 - 1. This allowance includes material, receiving, handling, and installation costs, and Contractor overhead and profit.
- D. Allowance No. 4: Lump-Sum Allowance: Include the sum of \$20,000.00 for interior signage.
 - 1. This allowance includes material only. **This will still require a product submittal.**
- E. Allowance No. 5: Lump-Sum Allowance: Include the sum of \$18,000.00 for conduit, power and power supplies, interface hardware, and cabling for exterior fence gates. Equipment and utilities shown on the drawings and in the specifications are base bid.
 - 1. This allowance includes material, receiving, handling, and installation costs, and Contractor overhead and profit.
- F. Allowance No. 6: Lump-Sum Allowance: Include the sum of \$100,000.00 for utility connection fees, including water, sewer, electricity, gas, and data/communications.
 - 1. This allowance includes procuring permits, engineering and tap fees, along with the required procurement and installation of materials, receiving, handling, and Contractor overhead and profit.

Maryland State Police
Tactical Administration Center
PA-745-210-001

G. Allowance No. 8: Quantity Allowance: Include 40 corner guards, as specified in Section 102600 "Wall and Door Protection." Corner guards indicated on plans shall be part of the allowance. Remaining corner guards will be installed at Owner direction.

1. Coordinate quantity allowance adjustment with unit-price requirements in Section 012200 "Unit Prices."

END OF SECTION 012100

SECTION 012200 - UNIT PRICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for unit prices.
- B. Related Requirements:
 - 1. Section 012100 "Allowances" for procedures for using unit prices to adjust quantity allowances.
 - 2. Section 012600 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.
 - 3. Section 014000 "Quality Requirements" for field testing by an independent testing agency.

1.3 DEFINITIONS

- A. Unit price is an amount incorporated into the Agreement, applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased. Unit prices shall not be a basis of payment for work that is within the defined scope of the project according to the Contract Documents.

1.4 PROCEDURES

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
- B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
- C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

- D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the Part 3 "Schedule of Unit Prices" Article contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF UNIT PRICES

- A. Unit Price No. 1: Removal of unsatisfactory soil and replacement with satisfactory soil material.
1. Description: Unsatisfactory soil excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, in accordance with Section 312000 "Earth Moving."
 2. Unit of Measurement: **cubic yard** of soil excavated, based on in-place surveys of volume before and after removal.
 3. Basis amount: 100 cubic yards
- B. Unit Price No. 2: Mass rock excavation and replacement with satisfactory soil material.
1. Description: Classified mass rock excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, in accordance with Section 312000 "Earth Moving."
 2. Unit of Measurement: **cubic yard** of rock excavated, based on in-place surveys of volume before and after removal.
 3. Basis amount: 20 cubic yards
- C. Unit Price No. 3: Trench rock excavation and replacement with satisfactory soil material.
1. Description: Classified trench rock excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, in accordance with Section 312000 "Earth Moving."
 2. Unit of Measurement: **cubic yard** of rock excavated, based on survey of in-place surveys volume of before and after removal.
 3. Basis amount: 20 cubic yards
- D. Unit Price No.4: Borrow materials.
1. Description: Additional soil, of satisfactory type(s), as defined in Division 31.
 2. Unit of Measurement: **cubic yard** of soil delivered.
 3. Basis amount: 100 cubic yards
- E. Unit Price No. 5: Contaminated Soils
1. Description: Excavation of contaminated soils as defined in Division 31
 2. Unit of Measurement: **cubic yard** of soil legally disposed.
 3. Basis amount: 20 cubic yards

- F. Unit Price No. 6: Asphalt paving
 - 1. Description: Typical asphalt paving, sub-base and prepared grade as shown on the Drawings
 - 2. Unit of Measurement: **Square yard, installed**
 - 3. Basis amount: 20 square yards

- G. Unit Price No. 7: Concrete paving
 - 1. Description: Typical concrete paving, sub-base and prepared grade as shown on the Drawings
 - 2. Unit of Measurement: **Square foot, installed**
 - 3. Basis amount: 100 square feet

- H. Unit Price No. 8: Curb and gutter
 - 1. Description: Typical concrete curb and gutter, sub-base and prepared grade as shown on the Drawings
 - 2. Unit of Measurement: **Linear foot, installed**
 - 3. Basis amount: 50 linear feet

- I. Unit Price No. 9: Chain link fencing
 - 1. Description: Typical 8' high-security chain link fencing, as specified
 - 2. Unit of Measurement: **Linear foot, installed**
 - 3. Basis amount: 50 linear feet

- J. Unit Price No. 10: Seeding
 - 1. Description: Typical grass seeding, including topsoil preparation, grading, stone removal and cover
 - 2. Unit of Measurement: **Square yard, installed**
 - 3. Basis amount: 100 square yards

- K. Unit Price No. 11: Moisture vapor emission control treatment
 - 1. Description: Treatments to control concrete slab moisture emission in accordance with Section 090561.13
 - 2. Unit of Measurement: **Square foot, installed**
 - 3. Basis amount: 1000 square feet

END OF SECTION 012200

SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
 - 2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

- A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1. Include, as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation, whether or not indicated as part of alternate.
- B. Execute accepted alternates under the same conditions as other Work of the Contract.
- C. Schedule: A Part 3 "Schedule of Alternates" Article is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

- A. Alternate No. 1: Specification Division 28, Electrical Safety and Security
 - 1. Alternate: All materials and installation specified in Division 28, Electrical Safety and Security . This includes all parts, cabling , equipment, conduit and boxes.
- B. Alternate No. 2: Specification Division 27, Communications
 - 1. Alternate: All materials and installation specified in Division 27, Communications. This includes all parts, equipment, cabling, conduit and boxes, and audio-video systems.
- C. Alternate No. 3: Explosives containment area
 - 1. Alternate: Explosives containment area, including site development, utilities, fencing, explosives containment units, storm water management and support pads, described as “Alternate 3” in the Contract Documents.
This includes Div 27 communications and Div 28 security and associated conduits and boxes that are associated with the explosives containment area, Refer to sheet T003.
- D. Alternate No. 4: Motorola grounding system
 - 1. Alternate: Work associated with grounding systems for radio transmission systems, described as “Alternate 4” in the Contract Documents.
This alternates includes the portion of the specification section 275200 Grounding & Bonding related to the R56 radio grounding system and R56 auditor & inspector (Refer to spec Section 275200-1.2.C and drawing T508)
- E. Alternate No. 5: Lobby Light Fixture
 - 1. Alternate: Provide and install Light Fixtures P1 and P3 in the Lobby, as specified and shown on the Electrical Drawings.

END OF SECTION 012300

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Document 002600 "Procurement Substitution Procedures" for requirements for substitution requests prior to award of Contract.
 - 2. Section 012100 "Allowances" for products selected under an allowance.
 - 3. Section 012300 "Alternates" for products selected under an alternate.
 - 4. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents.
 - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit documentation identifying product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use form acceptable to Architect.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

- a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
 - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.7 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

- 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

- a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
- b. Requested substitution provides sustainable design characteristics that specified product provided for compliance with LEED requirements.
- c. Substitution request is fully documented and properly submitted.
- d. Requested substitution will not adversely affect Contractor's construction schedule.
- e. Requested substitution has received necessary approvals of authorities having jurisdiction.
- f. Requested substitution is compatible with other portions of the Work.
- g. Requested substitution has been coordinated with other portions of the Work.
- h. Requested substitution provides specified warranty.
- i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

- B. Substitutions for Convenience: Architect will consider requests for substitution if received within 60 days after commencement of the Work. Requests received after that time may be considered or rejected at discretion of Architect.

- 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

- a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities

Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.

- b. Requested substitution does not require extensive revisions to the Contract Documents.
- c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
- d. Requested substitution provides sustainable design characteristics that specified product provided for compliance with LEED requirements.
- e. Substitution request is fully documented and properly submitted.
- f. Requested substitution will not adversely affect Contractor's construction schedule.
- g. Requested substitution has received necessary approvals of authorities having jurisdiction.
- h. Requested substitution is compatible with other portions of the Work.
- i. Requested substitution has been coordinated with other portions of the Work.
- j. Requested substitution provides specified warranty.
- k. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Requirements:
 - 1. Section 012500 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.
 - 2. Section 013100 "Project Management and Coordination" for requirements for forms for contract modifications provided as part of web-based Project management software.

1.3 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710.

1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
 - 2. Within time specified in Proposal Request or 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.

- d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 - e. Quotation Form: Use forms acceptable to Architect.
- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.
- 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
 - 2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - 4. Include costs of labor and supervision directly attributable to the change.
 - 5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 - 6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
 - 7. Proposal Request Form: Use form acceptable to Architect.

1.5 ADMINISTRATIVE CHANGE ORDERS

- A. Allowance Adjustment: See Section 012100 "Allowances" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.
- B. Unit-Price Adjustment: See Section 012200 "Unit Prices" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit-price work.

1.6 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Change Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.

1.7 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

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1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
 1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

SECTION 012900 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
 - 1. Document 004373 "Proposed Schedule of Values Form" for requirements for furnishing proposed schedule of values with bid.
 - 2. Section 012100 "Allowances" for procedural requirements governing the handling and processing of allowances.
 - 3. Section 012200 "Unit Prices" for administrative requirements governing the use of unit prices.
 - 4. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 5. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.
 - 6. [Section 018113.14](#) "Sustainable Design Requirements - LEED v4 BD+C" for administrative requirements governing submittal of cost breakdown information required for sustainable design documentation.

1.3 DEFINITIONS

- A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
 - 1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.

2. Submit the schedule of values to Architect at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
 3. Subschedules for Separate Elements of Work: Where the Contractor's construction schedule defines separate elements of the Work, provide subschedules showing values coordinated with each element.
- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
1. Identification: Include the following Project identification on the schedule of values:
 - a. Project name and location.
 - b. Owner's name.
 - c. Owner's Project number.
 - d. Name of Architect.
 - e. Architect's Project number.
 - f. Contractor's name and address.
 - g. Date of submittal.
 2. Arrange schedule of values consistent with format of AIA Document G703.
 3. Arrange the schedule of values in tabular form, with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent. Round dollar amounts to whole dollars, with total equal to Contract Sum.
 - 1) Labor.
 - 2) Materials.
 - 3) Equipment.
 4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
 5. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site.
 6. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.

7. Overhead Costs, Separate Line Items: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
8. Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
9. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

1.5 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments, as certified by Architect and paid for by Owner.
- B. Payment Application Times: The date for each progress payment is indicated in the Owner/Contractor Agreement. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
- C. Payment Application Times: Submit Application for Payment to Architect by the 20th of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.
 1. Submit draft copy of Application for Payment seven days prior to due date for review by Architect.
- D. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.
- E. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
 1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
 2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
 3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
 4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.
- F. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
 1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment for stored materials.

2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 3. Provide summary documentation for stored materials indicating the following:
 - a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
 - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
 - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- G. Transmittal: Submit three signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- H. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 2. When an application shows completion of an item, submit conditional final or full waivers.
 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
 5. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.
- I. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of values.
 3. Contractor's construction schedule (preliminary if not final).
 4. Combined Contractor's construction schedule (preliminary if not final) incorporating Work of multiple contracts, with indication of acceptance of schedule by each Contractor.
 5. Products list (preliminary if not final).
 6. Sustainable design action plans, including preliminary project materials cost data.
 7. Schedule of unit prices.
 8. Submittal schedule (preliminary if not final).
 9. List of Contractor's staff assignments.
 10. List of Contractor's principal consultants.
 11. Copies of building permits.

12. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 13. Initial progress report.
 14. Report of preconstruction conference.
 15. Certificates of insurance and insurance policies.
 16. Performance and payment bonds.
 17. Data needed to acquire Owner's insurance.
- J. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 - a. Complete administrative actions, submittals, and Work preceding this application, as described in Section 017700 "Closeout Procedures."
 2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- K. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
 2. Certification of completion of final punch list items.
 3. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 4. Updated final statement, accounting for final changes to the Contract Sum.
 5. AIA Document G706.
 6. AIA Document G706A.
 7. AIA Document G707.
 8. Evidence that claims have been settled.
 9. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
 10. Final liquidated damages settlement statement.
 11. Proof that taxes, fees, and similar obligations are paid.
 12. Waivers and releases.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. RFIs.
 - 4. Digital project management procedures.
 - 5. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
- C. Related Requirements:
 - 1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.
 - 4. Section 019113 "General Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

1.3 DEFINITIONS

- A. BIM: Building Information Modeling.
- B. RFI: Request for Information. Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
 2. Number and title of related Specification Section(s) covered by subcontract.
 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses, cellular telephone numbers, and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
1. Post copies of list in Project meeting room, in temporary field office, and in prominent location in built facility. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
1. Schedule construction operations in sequence required to obtain the best results, where installation of one part of the Work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's construction schedule.
 2. Preparation of the schedule of values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Preinstallation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.

1.6 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to coordination drawings in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - f. Indicate required installation sequences.
 - g. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Organize coordination drawings as follows:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
 2. Plenum Space: Indicate subframing for support of ceiling, raised access floor, and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
 3. Mechanical Rooms: Provide coordination drawings for mechanical rooms, showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
 4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
 5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
 6. Mechanical and Plumbing Work: Show the following:

- a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
7. Electrical Work: Show the following:
- a. Runs of vertical and horizontal conduit **1-1/4 inches (32 mm)** in diameter and larger.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
 - c. Panel board, switchboard, switchgear, transformer, busway, generator, and motor-control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
8. Fire-Protection System: Show the following:
- a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
9. Review: Architect will review coordination drawings to confirm that, in general, the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.
10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."
- C. Coordination Drawing Process: Prepare coordination drawings in the following manner:
1. Schedule submittal and review of Fire Sprinkler, Plumbing, HVAC, and Electrical Shop Drawings to make required changes prior to preparation of coordination drawings.
 2. Commence routing of coordination drawing files with HVAC Installer, who will provide drawing plan files denoting approved ductwork. HVAC Installer will locate ductwork and piping on a single layer, using orange color. Forward drawings to Plumbing Installer.
 3. Plumbing Installer will locate plumbing and equipment on a single layer, using blue color.
 4. Fire Sprinkler Installer will locate piping and equipment, using red color. Fire Sprinkler Installer shall forward drawing files to Electrical Installer.
 5. Electrical Installer will indicate service and feeder conduit runs and equipment in green color. Electrical Installer shall forward drawing files to Communications and Electronic Safety and Security Installer.
 6. Communications and Electronic Safety and Security Installer will indicate cable trays and cabling runs and equipment in purple color. Communications and Electronic Safety and Security Installer shall forward completed drawing files to Contractor.
 7. Contractor shall perform the final coordination review. As each coordination drawing is completed, Contractor will meet with Architect to review and resolve conflicts on the coordination drawings.

- D. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format:
 - a. Same digital data software program, version, and operating system as original Drawings.
 2. File Submittal Format: Submit or post coordination drawing files using format same as file preparation format.
 3. BIM File Incorporation: Develop and incorporate coordination drawing files into BIM established for Project.
 - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect.
 4. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.
 - a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
 - b. Digital Data Software Program: Drawings are available in Revit 2021 or latest version.
 - c. Contractor shall execute a data licensing agreement in the form of AIA Document C106.

1.7 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
 2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
 2. Owner name.
 3. Owner's Project number.
 4. Name of Architect.
 5. Architect's Project number.
 6. Date.
 7. Name of Contractor.

8. RFI number, numbered sequentially.
 9. RFI subject.
 10. Specification Section number and title and related paragraphs, as appropriate.
 11. Drawing number and detail references, as appropriate.
 12. Field dimensions and conditions, as appropriate.
 13. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 14. Contractor's signature.
 15. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.
1. Attachments shall be electronic files in PDF format.
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect of additional information.
 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 5 days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Include the following:
1. Project name.

2. Name and address of Contractor.
 3. Name and address of Architect.
 4. RFI number, including RFIs that were returned without action or withdrawn.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Architect's response was received.
 8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.
- F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within three days if Contractor disagrees with response.

1.8 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Use of Architect's Digital Data Files: Digital data files of Architect's BIM model will be provided by Architect for Contractor's use during construction.
1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project Record Drawings.
 2. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
 3. Digital Drawing Software Program: Contract Drawings are available in Revit 2021 or latest version.
 4. Contractor shall execute a data licensing agreement in the form of AIA Document C106 Digital Data Licensing Agreement.
 - a. Subcontractors and other parties granted access by Contractor to Architect's digital data files shall execute a data licensing agreement in the form of AIA Document C106.
 5. The following digital data files will be furnished for each appropriate discipline:
 - a. Floor plans.
 - b. Reflected ceiling plans.
 - c. Revit model.
- B. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:
1. Assemble complete submittal package into a single indexed file, incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.9 PROJECT MEETINGS

- A. General: Owner will schedule and conduct meetings and conferences at Project site unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times a minimum of seven days prior to meeting.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.
- B. Preconstruction Conference: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.
1. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Responsibilities and personnel assignments.
 - b. Tentative construction schedule.
 - c. Phasing.
 - d. Critical work sequencing and long lead items.
 - e. Designation of key personnel and their duties.
 - f. Lines of communications.
 - g. Use of web-based Project software.
 - h. Procedures for processing field decisions and Change Orders.
 - i. Procedures for RFIs.
 - j. Procedures for testing and inspecting.
 - k. Procedures for processing Applications for Payment.
 - l. Distribution of the Contract Documents.
 - m. Submittal procedures.
 - n. Sustainable design requirements.
 - o. Preparation of Record Documents.
 - p. Use of the premises.
 - q. Work restrictions.
 - r. Working hours.
 - s. Owner's occupancy requirements.
 - t. Responsibility for temporary facilities and controls.
 - u. Procedures for moisture and mold control.
 - v. Procedures for disruptions and shutdowns.
 - w. Construction waste management and recycling.
 - x. Parking availability.
 - y. Office, work, and storage areas.
 - z. Equipment deliveries and priorities.

- aa. Security.
 - bb. Progress cleaning.
 - 3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Sustainable Design Requirements Coordination Conference: Owner will schedule and conduct a sustainable design coordination conference before starting construction, at a time convenient to Owner Architect, and Contractor.
- 1. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent and sustainable design coordinator; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 2. Agenda: Discuss items of significance that could affect meeting sustainable design requirements, including the following:
 - a. Sustainable design Project checklist.
 - b. General requirements for sustainable design-related procurement and documentation.
 - c. Project closeout requirements and sustainable design certification procedures.
 - d. Role of sustainable design coordinator.
 - e. Construction waste management.
 - f. Construction operations and sustainable design requirements and restrictions.
 - 3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- D. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other Sections and when required for coordination with other construction.
- 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
 - 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Sustainable design requirements.
 - i. Review of mockups.
 - j. Possible conflicts.

- k. Compatibility requirements.
 - l. Time schedules.
 - m. Weather limitations.
 - n. Manufacturer's written instructions.
 - o. Warranty requirements.
 - p. Compatibility of materials.
 - q. Acceptability of substrates.
 - r. Temporary facilities and controls.
 - s. Space and access limitations.
 - t. Regulations of authorities having jurisdiction.
 - u. Testing and inspecting requirements.
 - v. Installation procedures.
 - w. Coordination with other work.
 - x. Required performance results.
 - y. Protection of adjacent work.
 - z. Protection of construction and personnel.
3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- E. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of Record Documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Procedures for completing and archiving web-based Project software site data files.
 - d. Submittal of written warranties.
 - e. Requirements for completing sustainable design documentation.
 - f. Requirements for preparing operations and maintenance data.
 - g. Requirements for delivery of material samples, attic stock, and spare parts.
 - h. Requirements for demonstration and training.
 - i. Preparation of Contractor's punch list.

- j. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - k. Submittal procedures.
 - l. Owner's partial occupancy requirements.
 - m. Installation of Owner's furniture, fixtures, and equipment.
 - n. Responsibility for removing temporary facilities and controls.
 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- F. Progress Meetings: Architect will conduct progress meetings at biweekly intervals.
 1. Coordinate dates of meetings with preparation of payment requests.
 2. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Status of sustainable design documentation.
 - 6) Deliveries.
 - 7) Off-site fabrication.
 - 8) Access.
 - 9) Site use.
 - 10) Temporary facilities and controls.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Status of correction of deficient items.
 - 14) Field observations.
 - 15) Status of RFIs.
 - 16) Status of Proposal Requests.
 - 17) Pending changes.
 - 18) Status of Change Orders.

- 19) Pending claims and disputes.
 - 20) Documentation of information for payment requests.
4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- G. Coordination Meetings: Conduct Project coordination meetings at biweekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
1. Attendees: Each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site use.
 - 9) Temporary facilities and controls.
 - 10) Work hours.
 - 11) Hazards and risks.
 - 12) Progress cleaning.
 - 13) Quality and work standards.
 - 14) Status of RFIs.
 - 15) Proposal Requests.

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PA-745-210-001

- 16) Change Orders.
 - 17) Pending changes.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Startup construction schedule.
 - 2. Contractor's Construction Schedule.
 - 3. Construction schedule updating reports.
 - 4. Daily construction reports.
 - 5. Material location reports.
 - 6. Site condition reports.
 - 7. Unusual event reports.
- B. Related Requirements:
 - 1. Section 014000 "Quality Requirements" for schedule of tests and inspections.
 - 2. Section 012900 "Payment Procedures" for schedule of values and requirements for use of cost-loaded schedule for Applications for Payment.

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for completing an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine the critical path of Project and when activities can be performed.

- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Resource Loading: The allocation of manpower and equipment necessary for completing an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. PDF file.
- B. Startup construction schedule.
 - 1. Submittal of cost-loaded startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.
- C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
- D. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
 - 1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
 - 2. Logic Report: List of preceding and succeeding activities for each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.
 - 3. Total Float Report: List of activities sorted in ascending order of total float.
 - 4. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment.
- E. Construction Schedule Updating Reports: Submit with Applications for Payment.
- F. Daily Construction Reports: Submit at monthly intervals.

- G. Material Location Reports: Submit at [**weekly**] [**monthly**] intervals.
- H. Site Condition Reports: Submit at time of discovery of differing conditions.
- I. Unusual Event Reports: Submit at time of unusual event.

1.5 COORDINATION

- A. Coordinate Contractor's Construction Schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from entities involved.
 - 2. Coordinate each construction activity in the network with other activities, and schedule them in proper sequence.

1.6 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
- B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Final Completion.
 - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
 - 1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
 - 2. Temporary Facilities: Indicate start and completion dates for the following as applicable:
 - a. Securing of approvals and permits required for performance of the Work.
 - b. Temporary facilities.
 - c. Construction of mock-ups, prototypes and samples.
 - d. Owner interfaces and furnishing of items.
 - e. Interfaces with Separate Contracts.
 - f. Regulatory agency approvals.
 - g. Punch list.
 - 3. Procurement Activities: Include procurement process activities for the following long lead-time items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.

4. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
 5. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
 6. Commissioning Time: Include no fewer than 15 days for commissioning.
 7. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
 8. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and Final Completion.
- D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.
 - d. Use-of-premises restrictions.
 - e. Provisions for future construction.
 - f. Seasonal variations.
 - g. Environmental control.
 2. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Building flush-out.
 - m. Startup and placement into final use and operation.
 - n. Commissioning.
 3. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Structural completion.
 - b. Temporary enclosure and space conditioning.
 - c. Permanent space enclosure.
 - d. Completion of mechanical installation.
 - e. Completion of electrical installation.

- f. Substantial Completion.
- E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.
 - 1. Temporary enclosure and space conditioning.
- F. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
 - 1. See Section 012900 "Payment Procedures" for cost reporting and payment procedures.
- G. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
 - 1. Unresolved issues.
 - 2. Unanswered Requests for Information.
 - 3. Rejected or unreturned submittals.
 - 4. Notations on returned submittals.
 - 5. Pending modifications affecting the Work and the Contract Time.
- H. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
 - 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 - 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 - 3. As the Work progresses, indicate Final Completion percentage for each activity.
- I. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.
- J. Distribution: Distribute copies of approved schedule to Architect Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
 - 1. Post copies in Project meeting rooms and temporary field offices.
 - 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.7 STARTUP CONSTRUCTION SCHEDULE

- A. Gantt-Chart Schedule: Submit startup, horizontal, Gantt-chart-type construction schedule within seven days of date established for the Notice to Proceed.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

1.8 GANTT-CHART SCHEDULE REQUIREMENTS

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for the Notice to Proceed.
 - 1. Base schedule on the startup construction schedule and additional information received since the start of Project.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
 - 1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in [10] <Insert number> percent increments within time bar.

1.9 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
 - 1. List of subcontractors at Project site.
 - 2. List of separate contractors at Project site.
 - 3. Approximate count of personnel at Project site.
 - 4. Equipment at Project site.
 - 5. Material deliveries.
 - 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 - 7. Testing and inspection.
 - 8. Accidents.
 - 9. Meetings and significant decisions.
 - 10. Unusual events.
 - 11. Stoppages, delays, shortages, and losses.
 - 12. Meter readings and similar recordings.
 - 13. Emergency procedures.
 - 14. Orders and requests of authorities having jurisdiction.
 - 15. Change Orders received and implemented.
 - 16. Construction Change Directives received and implemented.
 - 17. Services connected and disconnected.

18. Equipment or system tests and startups.
 19. Partial completions and occupancies.
 20. Substantial Completions authorized.
- B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
1. Material stored prior to previous report and remaining in storage.
 2. Material stored prior to previous report and since removed from storage and installed.
 3. Material stored following previous report and remaining in storage.
- C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.
- D. Unusual Event Reports: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.
1. Submit unusual event reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013200

SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Concealed Work photographs.
 - 3. Periodic construction photographs.
 - 4. Final Completion construction photographs.
 - 5. Preconstruction video recordings.
 - 6. Periodic construction video recordings.
- B. Related Requirements:
 - 1. Section 017700 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.
 - 2. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.
 - 3. Section 024116 "Structure Demolition" for photographic documentation before building demolition operations commence.
 - 4. Section 024119 "Selective Demolition" for photographic documentation before selective demolition operations commence.
 - 5. Section 311000 "Site Clearing" for photographic documentation before site clearing operations commence.

1.3 INFORMATIONAL SUBMITTALS

- A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph and video recording. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- B. Digital Photographs: Submit image files within three days of taking photographs.
 - 1. Submit photos on thumb-drive. Include copy of key plan indicating each photograph's location and direction.
 - 2. Identification: Provide the following information with each image description in file metadata tag:

- a. Name of Project.
- b. Name and contact information for photographer.
- c. Name of Architect.
- d. Name of Contractor.
- e. Date photograph was taken.
- f. Description of location, vantage point, and direction.
- g. Unique sequential identifier keyed to accompanying key plan.

C. Video Recordings: Submit video recordings within seven days of recording.

1. Submit video recordings on thumb drive. Include copy of key plan indicating each video's location and direction.
2. Identification: With each submittal, provide the following information in file metadata tag:
 - a. Name of Project.
 - b. Name and address of photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date video recording was recorded.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
3. Transcript: Prepared on **8-1/2-by-11-inch (215-by-280-mm)** paper, punched and bound in three-ring binders. Provide label on front and spine. Include a cover sheet with label information. Include name of Project and date of video recording on each page.

1.4 FORMATS AND MEDIA

- A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels. Use flash in low light levels or backlit conditions.
- B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full high-definition mode. Provide supplemental lighting in low light levels or backlit conditions.
- C. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
- D. Metadata: Record accurate date and time from camera.
- E. File Names: Name media files with date and sequential numbering suffix.

1.5 CONSTRUCTION PHOTOGRAPHS

- A. Photographer: Engage a qualified photographer to take construction photographs.

- B. General: Take photographs with maximum depth of field and in focus.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- C. Preconstruction Photographs: Before commencement of the Work, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
 - 1. Flag excavation areas before taking construction photographs.
 - 2. Take 20 photographs to show existing conditions adjacent to property before starting the Work.
 - 3. Take 12 photographs of existing buildings either on or adjoining property, to accurately record physical conditions at start of construction.
 - 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- D. Concealed Work Photographs: Before proceeding with installing work that will conceal other work, take photographs sufficient in number, with annotated descriptions, to record nature and location of concealed Work, including, but not limited to, the following:
 - 1. Underground utilities.
 - 2. Underslab services.
 - 3. Piping.
 - 4. Electrical conduit.
 - 5. Waterproofing and weather-resistant barriers.
- E. Periodic Construction Photographs: Take 20 photographs weekly. Select vantage points to show status of construction and progress since last photographs were taken.
- F. Final Completion Construction Photographs: Take 50 photographs after date of Substantial Completion for submission as Project Record Documents. Architect will inform photographer of desired vantage points.
- G. Additional Photographs: Architect may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.
 - 1. Three days' notice will be given, where feasible.
 - 2. In emergency situations, take additional photographs within 24 hours of request.
 - 3. Circumstances that could require additional photographs include, but are not limited to, the following:
 - a. Special events planned at Project site.
 - b. Immediate follow-up when on-site events result in construction damage or losses.
 - c. Photographs shall be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
 - d. Substantial Completion of a major phase or component of the Work.
 - e. Extra record photographs at time of final acceptance.
 - f. Owner's request for special publicity photographs.

1.6 CONSTRUCTION VIDEO RECORDINGS

- A. Preconstruction Video Recording: Before starting excavation, record video recording of Project site and surrounding properties from different vantage points, as directed by Architect.
 - 1. Flag excavation areas before recording construction video recordings.
 - 2. Show existing conditions adjacent to Project site before starting the Work.
 - 3. Show existing buildings either on or adjoining Project site to accurately record physical conditions at the start of excavation.
 - 4. Show protection efforts by Contractor.

- B. Periodic Construction Video Recordings: Record video recording monthly. Select vantage points to show status of construction and progress since last video recordings were recorded. Minimum recording time shall be 5 minutes(s).

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013233

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

B. Related Requirements:

1. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
2. Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
3. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
4. Section 013233 "Photographic Documentation" for submitting preconstruction photographs, periodic construction photographs, and Final Completion construction photographs.
5. Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
6. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
7. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
8. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
9. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.
10. [Section 018113.14](#) "Sustainable Design Requirements - LEED v4 BD+C" for sustainable design submittals.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.3 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.
1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 2. Initial Submittal Schedule: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 3. Final Submittal Schedule: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule as required to reflect changes in current status and timing for submittals.
 4. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal Category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Architect's final release or approval.
 - g. Scheduled dates for purchasing.
 - h. Scheduled date of fabrication.
 - i. Scheduled dates for installation.
 - j. Activity or event number.

1.4 SUBMITTAL FORMATS

- A. Submittal Information: Include the following information in each submittal:
1. Project name.
 2. Date.
 3. Name of Architect.
 4. Name of Contractor.
 5. Name of firm or entity that prepared submittal.
 6. Names of subcontractor, manufacturer, and supplier.
 7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier and alphanumeric suffix for resubmittals.
 8. Category and type of submittal.
 9. Submittal purpose and description.
 10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.

11. Drawing number and detail references, as appropriate.
12. Indication of full or partial submittal.
13. Location(s) where product is to be installed, as appropriate.
14. Other necessary identification.
15. Remarks.
16. Signature of transmitter.

- B. Options: Identify options requiring selection by Architect.
- C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- D. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

1.5 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Email: Prepare submittals as PDF package and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.
 - a. Architect will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections, so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the

Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 15 days for review of each resubmittal.
4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow 15 days for review of each submittal. Submittal will be returned to Architect before being returned to Contractor.
 - a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect.

D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block, and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

1.6 SUBMITTAL REQUIREMENTS

A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.

- e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams that show factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before Shop Drawings, and before or concurrently with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Architect's digital data drawing files is otherwise permitted.
 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. BIM Incorporation: Develop and incorporate required coordination drawing files into BIM established for Project.
- C. Samples: Submit Samples for review of type, color, pattern, and texture for a check of these characteristics with other materials.
 1. Transmit Samples that contain multiple, related components, such as accessories together in one submittal package.
 2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
 - a. Project name and submittal number.
 - b. Generic description of Sample.
 - c. Product name and name of manufacturer.
 - d. Sample source.
 - e. Number and title of applicable Specification Section.
 - f. Specification paragraph number and generic name of each item.
 3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics and identification information for record.

4. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
 5. Paper Transmittal: Include paper transmittal, including complete submittal information indicated.
 6. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 7. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units, showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
 8. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record Sample.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.

4. Location within room or space.
- E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- G. Certificates:
1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
 2. Installer Certificates: Submit written statements on manufacturer's letterhead, certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
 3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
 4. Material Certificates: Submit written statements on manufacturer's letterhead, certifying that material complies with requirements in the Contract Documents.
 5. Product Certificates: Submit written statements on manufacturer's letterhead, certifying that product complies with requirements in the Contract Documents.
 6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of AWS B2.1/B2.1M on AWS forms. Include names of firms and personnel certified.
- H. Test and Research Reports:
1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
 2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
 3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
 4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
 5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on

evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - a. Name of evaluation organization.
 - b. Date of evaluation.
 - c. Time period when report is in effect.
 - d. Product and manufacturers' names.
 - e. Description of product.
 - f. Test procedures and results.
 - g. Limitations of use.

1.7 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.
- C. BIM Incorporation: Incorporate delegated design coordination drawing and data files into BIM established for Project where required.
 1. Prepare delegated design drawings in the following format: Same digital data software program, version, and operating system as original Drawings.

1.8 CONTRACTOR'S REVIEW

- A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Contractor's approval, and statement

certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

1.9 ARCHITECT'S REVIEW

- A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required, and return.
 1. PDF Submittals: Architect will indicate, via markup on each submittal, the appropriate action.
- B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Architect will discard submittals received from sources other than Contractor.
- F. Submittals not required by the Contract Documents will be returned by Architect without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, Commissioning Authority, or authorities having jurisdiction are not limited by provisions of this Section.
- C. Related Requirements:
 - 1. Section 012100 "Allowances" for testing and inspection allowances.

1.3 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of [five] <Insert number> previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
 - 1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).
- D. Mockups: Physical assemblies of portions of the Work constructed to establish the standard by which the Work will be judged. Mockups are not Samples.
 - 1. Mockups are used for one or more of the following:
 - a. Verify selections made under Sample submittals.
 - b. Demonstrate aesthetic effects.
 - c. Demonstrate the qualities of products and workmanship.
 - d. Demonstrate successful installation of interfaces between components and systems.
 - e. Perform preconstruction testing to determine system performance.
 - 2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
 - 3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.
- E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.
- F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- G. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."
- I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect.

1.4 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated Design Services Statement: Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.5 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.6 ACTION SUBMITTALS

- A. Mockup Shop Drawings:
 - 1. Include plans, sections, elevations, and details, indicating materials and size of mockup construction.
 - 2. Indicate manufacturer and model number of individual components.
 - 3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.7 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.

- C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
 - 2. Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
 - D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
 - E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.
 - F. Reports: Prepare and submit certified written reports and documents as specified.
 - G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.
- 1.8 CONTRACTOR'S QUALITY-CONTROL PLAN
- A. Quality-Control Plan, General: Submit quality-control plan within days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities and to coordinate Owner's quality-assurance and quality-control activities. Coordinate with Contractor's Construction Schedule.
 - B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
 - 1. Project quality-control manager may also serve as Project superintendent.

- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
 - 1. Contractor-performed tests and inspections, including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
 - 2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
 - 3. Owner-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by Commissioning Authority.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring the Work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports, including log of approved and rejected results. Include Work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming Work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.9 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, telephone number, and email address of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.
 - 10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
 - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 - 12. Name and signature of laboratory inspector.
 - 13. Recommendations on retesting and reinspecting.

- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement of whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement of whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE

- A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed

for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.

- F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.
 - 1. Requirements of authorities having jurisdiction supersede requirements for specialists.
- G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following Contractor's responsibilities, including the following:
 - 1. Provide test specimens representative of proposed products and construction.
 - 2. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - 3. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - 4. Build site-assembled test assemblies and mockups, using installers who will perform same tasks for Project.
 - 5. When testing is complete, remove test specimens and test assemblies; do not reuse products on Project.
 - 6. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect and Commissioning Authority, with copy to Contractor. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
- K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Build mockups of size indicated.
 - 2. Build mockups in location indicated or, if not indicated, as directed by Architect.

3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 4. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
 5. Demonstrate the proposed range of aesthetic effects and workmanship.
 6. Obtain Architect's approval of mockups before starting corresponding Work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 7. Promptly correct unsatisfactory conditions noted by Architect's preliminary review, to the satisfaction of the Architect, before completion of final mockup.
 8. Approval of mockups by the Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 10. Demolish and remove mockups when directed unless otherwise indicated.
- L. Specialty Mockups: See Section 014339 "Mockups" for additional construction requirements for integrated exterior mockups.

1.11 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
 2. Payment for these services will be made from testing and inspection allowances specified in Section 012100 "Allowances," as authorized by Change Orders.
 3. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. Engage a qualified testing agency to perform quality-control services.
 - a. Contractor will not employ same entity engaged by Owner, unless agreed to in writing by Owner.

3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- D. Testing Agency Responsibilities: Cooperate with Architect, Commissioning Authority and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect, Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform duties of Contractor.
- E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."
- F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.

5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspection equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's Construction Schedule. Update and submit with each Application for Payment.
1. Schedule Contents: Include tests, inspections, and quality-control services, including Contractor- and Owner-retained services, commissioning activities, and other Project-required services paid for by other entities.
 2. Distribution: Distribute schedule to Owner, Architect, Commissioning Authority, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.12 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Owner will engage a qualified testing agency and special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures, and reviewing the completeness and adequacy of those procedures to perform the Work.
 2. Notifying Architect, Commissioning Authority, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect and Commissioning Authority with copy to Contractor and to authorities having jurisdiction.
 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 5. Interpreting tests and inspections, and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
 6. Retesting and reinspecting corrected Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's, Commissioning Authority's, and authorities' having jurisdiction reference during normal working hours.

1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms, including "requested," "authorized," "selected," "required," and "permitted," have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms, including "shown," "noted," "scheduled," and "specified," have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
 - 1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.

- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
 - 1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.3 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."
- B. Industry Organizations, List: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. Abbreviations and acronyms not included in this list are to mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States." The information in this list is subject to change and is believed to be accurate as of the date of the Contract Documents.
 - 1. AABC - Associated Air Balance Council; www.aabc.com.
 - 2. AAMA - American Architectural Manufacturers Association; (see FGIA).
 - 3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
 - 4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
 - 5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
 - 6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
 - 7. ABMA - American Boiler Manufacturers Association; www.abma.com.
 - 8. ACI - American Concrete Institute; www.concrete.org.
 - 9. ACP - American Clean Power; (Formerly: American Wind Energy Association); www.cleanpower.org.
 - 10. ACPA - American Concrete Pipe Association; www.concretepipe.org.
 - 11. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
 - 12. AF&PA - American Forest & Paper Association; www.afandpa.org.
 - 13. AGA - American Gas Association; www.aga.org.
 - 14. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
 - 15. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
 - 16. AI - Asphalt Institute; www.asphaltinstitute.org.
 - 17. AIA - American Institute of Architects (The); www.aia.org.
 - 18. AISC - American Institute of Steel Construction; www.aisc.org.
 - 19. AISI - American Iron and Steel Institute; www.steel.org.
 - 20. AITC - American Institute of Timber Construction; (see PLIB).
 - 21. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
 - 22. AMPP - Association for Materials Protection and Performance; www.ampp.org.
 - 23. ANSI - American National Standards Institute; www.ansi.org.
 - 24. AOSA/SCST - Association of Official Seed Analysts (The)/Society of Commercial Seed Technologists (The); www.analyzeseeds.com.

25. APA - APA - The Engineered Wood Association; www.apawood.org.
26. APA - Architectural Precast Association; www.archprecast.org.
27. API - American Petroleum Institute; www.api.org.
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASA - Acoustical Society of America; www.acousticalsociety.org.
30. ASCE - American Society of Civil Engineers; www.asce.org.
31. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (see ASCE).
32. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
33. ASME - ASME International; American Society of Mechanical Engineers (The); www.asme.org.
34. ASSE - ASSE International; (American Society of Sanitary Engineering); www.asse-plumbing.org.
35. ASSP - American Society of Safety Professionals; www.assp.org.
36. ASTM - ASTM International; www.astm.org.
37. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
38. AVIXA - Audiovisual and Integrated Experience Association; www.avixa.org.
39. AWI - Architectural Woodwork Institute; www.awinet.org.
40. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
41. AWPA - American Wood Protection Association; www.awpa.com.
42. AWS - American Welding Society; www.aws.org.
43. AWWA - American Water Works Association; www.awwa.org.
44. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
45. BIA - Brick Industry Association (The); www.gobrick.com.
46. BICSI - BICSI, Inc.; www.bicsi.org.
47. BIFMA - Business and Institutional Furniture Manufacturer's Association; www.bifma.org.
48. CARB - California Air Resources Board; www.arb.ca.gov.
49. CDA - Copper Development Association Inc.; www.copper.org.
50. CE - Conformance Européenne (European Commission); www.ec.europa.eu/growth/single-market/ce-marking.
51. CEA - Canadian Electricity Association; www.electricity.ca.
52. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
53. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
54. CGA - Compressed Gas Association; www.cganet.com.
55. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
56. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
57. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
58. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
59. CPA - Composite Panel Association; www.compositepanel.org.
60. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
61. CRRC - Cool Roof Rating Council; www.coolroofs.org.
62. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
63. CSA - CSA Group; www.csagroup.org.
64. CSI - Cast Stone Institute; www.caststone.org.
65. CSI - Construction Specifications Institute (The); www.csiresources.org.
66. CTA - Consumer Technology Association; www.cta.tech.
67. CTI - Cooling Technology Institute; www.coolingtechnology.org.

68. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
69. DHA - Decorative Hardwoods Association; www.decorativehardwoods.org.
70. DHI - Door and Hardware Institute; www.dhi.org.
71. ECIA - Electronic Components Industry Association; www.ecianow.org.
72. EIMA - EIFS Industry Members Association; www.eima.com.
73. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
74. EOS/ESD - EOS/ESD Association, Inc.; Electrostatic Discharge Association; www.esda.org.
75. ESTA - Entertainment Services and Technology Association; www.esta.org.
76. EVO - Efficiency Valuation Organization; www.evo-world.org.
77. FCI - Fluid Controls Institute; www.fluidcontrolsintitute.org.
78. FGIA - Fenestration and Glazing Industry Alliance; <https://fgiaonline.org>.
79. FM Approvals - FM Approvals LLC; www.fmapprovals.com.
80. FM Global - FM Global; www.fmglobal.com.
81. FSA - Fluid Sealing Association; www.fluidsealing.com.
82. FSC - Forest Stewardship Council U.S.; www.fscus.org.
83. GA - Gypsum Association; www.gypsum.org.
84. GS - Green Seal; www.greenseal.org.
85. HI - Hydraulic Institute; www.pumps.org.
86. HMMA - Hollow Metal Manufacturers Association; (see NAAMM).
87. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
88. IAS - International Accreditation Service; www.iasonline.org.
89. ICC - International Code Council; www.iccsafe.org.
90. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
91. ICPA - International Cast Polymer Association (The); www.theicpa.com.
92. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
93. IEC - International Electrotechnical Commission; www.iec.ch.
94. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
95. IES - Illuminating Engineering Society; www.ies.org.
96. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
97. IGMA - Insulating Glass Manufacturers Alliance; (see FGIA).
98. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.org.
99. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
100. Intertek - Intertek Group; www.intertek.com.
101. ISA - International Society of Automation (The); www.isa.org.
102. ISFA - International Surface Fabricators Association; www.isfanow.org.
103. ISO - International Organization for Standardization; www.iso.org.
104. ITU - International Telecommunication Union; www.itu.int.
105. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
106. LPI - Lightning Protection Institute; www.lightning.org.
107. MBMA - Metal Building Manufacturers Association; www.mbma.com.
108. MCA - Metal Construction Association; www.metalconstruction.org.
109. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
110. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
111. MHI - Material Handling Industry; www.mhi.org.
112. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
113. MPI - Master Painters Institute; www.paintinfo.com.
114. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry, Inc.; www.msshq.org.

115. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
116. NACE - NACE International; (National Association of Corrosion Engineers International); (see AMPP).
117. NADCA - National Air Duct Cleaners Association; www.nadca.com.
118. NAIMA - North American Insulation Manufacturers Association; www.insulationinstitute.org.
119. NALP - National Association of Landscape Professionals; www.landscapeprofessionals.org.
120. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
121. NBI - New Buildings Institute; www.newbuildings.org.
122. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
123. NCMA - National Concrete Masonry Association; www.ncma.org.
124. NEBB - National Environmental Balancing Bureau; www.nebb.org.
125. NECA - National Electrical Contractors Association; www.necanet.org.
126. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
127. NEMA - National Electrical Manufacturers Association; www.nema.org.
128. NETA - InterNational Electrical Testing Association; www.netaworld.org.
129. NFHS - National Federation of State High School Associations; www.nfhs.org.
130. NFPA - National Fire Protection Association; www.nfpa.org.
131. NFPA - NFPA International; (see NFPA).
132. NFRC - National Fenestration Rating Council; www.nfrc.org.
133. NGA - National Glass Association; www.glass.org.
134. NHLA - National Hardwood Lumber Association; www.nhla.com.
135. NLGA - National Lumber Grades Authority; www.nlga.org.
136. NOFMA - National Oak Flooring Manufacturers Association; (see NWFA).
137. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
138. NRCA - National Roofing Contractors Association; www.nrca.net.
139. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
140. NSF - NSF International; www.nsf.org.
141. NSI - Natural Stone Institute; www.naturalstoneinstitute.org.
142. NSPE - National Society of Professional Engineers; www.nspe.org.
143. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
144. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
145. NWFA - National Wood Flooring Association; www.nwfa.org.
146. NWRA - National Waste & Recycling Association; www.wasterecycling.org.
147. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
148. PDI - Plumbing & Drainage Institute; www.pdionline.org.
149. PLASA - PLASA; www.plasa.org.
150. PLIB - Pacific Lumber Inspection Bureau; www.plib.org.
151. PVCPA - Uni-Bell PVC Pipe Association; www.uni-bell.org.
152. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
153. RFCI - Resilient Floor Covering Institute; www.rfci.com.
154. SAE - SAE International; www.sae.org.
155. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
156. SDI - Steel Deck Institute; www.sdi.org.
157. SDI - Steel Door Institute; www.steeldoor.org.
158. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
159. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (see ASCE).

160. SIA - Security Industry Association; www.securityindustry.org.
 161. SJI - Steel Joist Institute; www.steeljoist.org.
 162. SMA - Screen Manufacturers Association; www.smainfo.org.
 163. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
 164. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
 165. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
 166. SPIB - Southern Pine Inspection Bureau; www.spib.org.
 167. SPRI - Single Ply Roofing Industry; www.spri.org.
 168. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
 169. SSINA - Specialty Steel Industry of North America; www.ssina.com.
 170. SSPC - SSPC: The Society for Protective Coatings; (see AMPP).
 171. STI/SPFA - Steel Tank Institute/Steel Plate Fabricators Association; www.steeltank.com.
 172. SWI - Steel Window Institute; www.steelwindows.com.
 173. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
 174. TCNA - Tile Council of North America, Inc.; www.tcnatile.com.
 175. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.kbcdco.tema.org.
 176. TIA - Telecommunications Industry Association (The); www.tiaonline.org.
 177. TMS - The Masonry Society; www.masonrysociety.org.
 178. TPI - Truss Plate Institute; www.tpinst.org.
 179. TPI - Turfgrass Producers International; www.turfgrasssod.org.
 180. TRI - Tile Roofing Industry Alliance; www.tilerroofing.org.
 181. UL - Underwriters Laboratories Inc.; www.ul.org.
 182. UL LLC - UL LLC; www.ul.com.
 183. USAV - USA Volleyball; www.usavolleyball.org.
 184. USGBC - U.S. Green Building Council; www.usgbc.org.
 185. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
 186. WA - Wallcoverings Association; www.wallcoverings.org.
 187. WCLIB - West Coast Lumber Inspection Bureau; (see PLIB).
 188. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
 189. WDMA - Window & Door Manufacturers Association; www.wdma.com.
 190. WI - Woodwork Institute; www.woodworkinstitute.com.
 191. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
 192. WWPA - Western Wood Products Association; www.wwpa.org.
- C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.
1. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
 2. ICC - International Code Council; www.iccsafe.org.
 3. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.
- D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.
1. CPSC - U.S. Consumer Product Safety Commission; www.cpsc.gov.
 2. DOC - U.S. Department of Commerce; www.commerce.gov.
 3. DOE - U.S. Department of Energy; www.energy.gov.

4. DOJ - U.S. Department of Justice; www.ojp.usdoj.gov
5. EPA - United States Environmental Protection Agency; www.epa.gov.
6. GPO - U.S. Government Publishing Office; www.gpo.gov.
7. GSA - U.S. General Services Administration; www.gsa.gov.
8. NIST - National Institute of Standards and Technology; www.nist.gov.
9. OSHA - Occupational Safety & Health Administration; www.osha.gov.
10. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
11. USACE - U.S. Army Corps of Engineers; www.usace.army.mil.
12. USDA - U.S. Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
13. USDA - U.S. Department of Agriculture; Rural Utilities Service; www.usda.gov.

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from U.S. Government Publishing Office; www.govinfo.gov.
2. DOD - U.S. Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.dsp.dla.mil/Specs-Standards/.
3. DSCC - Defense Supply Center Columbus; (see FS).
4. FED-STD - Federal Standard; (see FS).
5. FS - Federal Specification; Available from DLA Document Services; www.dsp.dla.mil/Specs-Standards/.
 - a. Available from Defense Standardization Program; www.dsp.dla.mil.
 - b. Available from U.S. General Services Administration; www.gsa.gov.
 - c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org.
6. USAB - United States Access Board; www.access-board.gov.
7. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (see USAB).

F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. DGS; Maryland Department of General Services
2. MSP; Maryland State Police, Maryland Department of Police
3. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.oal.ca.gov/publications/ccr/.
4. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cdph.ca.gov/Programs/CCDPPP/DEODC/EHLB/IAQ/Pages/Main-Page.aspx.
5. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.

Maryland State Police
Tactical Administration Center
PA-745-210-001

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

- A. Installation, removal, and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Architect, testing agencies, and authorities having jurisdiction.
- B. Water Service: Owner will pay water-service use charges for water used by all entities for construction operations.
- C. Electric Power Service: Owner will pay electric-power-service use charges for electricity used by all entities for construction operations.
- D. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- E. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.4 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.

- B. Implementation and Termination Schedule: Within [15] <Insert number> days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.
- C. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, tpestyles, graphic elements, and message content.
- D. Erosion and Sedimentation Control Plan: Show compliance with requirements of 2003 EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
- E. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- F. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold. Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
 - 1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and requirements for replacing water-damaged Work.
 - 2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
 - 3. Indicate methods to be used to avoid trapping water in finished work.

1.5 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.6 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portable Chain-Link Fencing: Minimum 2-inch (50-mm), 0.148-inch- (3.8-mm-) thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized-steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top and bottom rails. Provide bases for supporting posts.

2.2 TEMPORARY FACILITIES

- A. Field Offices: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading. Refer to Section 015010, Temporary Facilities and Controls – State Field Offices, for specific requirements.
- B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 - 1. Store combustible materials apart from building.

2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating, Cooling, and Dehumidifying Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
 - 3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures."

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

- A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
 - 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work.

3.2 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
 - 1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.3 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- C. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Use of Permanent Toilets: Use of Owner's existing or new toilet facilities is not permitted.
- D. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.
- E. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
 1. Connect temporary service to Owner's existing power source, as directed by Owner.
- F. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.4 SUPPORT FACILITIES INSTALLATION

- A. Comply with the following:
 1. Provide construction for temporary field offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines that is noncombustible in accordance with ASTM E136. Comply with NFPA 241.
 2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.
 1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- C. Temporary Use of Planned Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
 1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
 2. Prepare subgrade and install subbase and base for temporary roads and paved areas in accordance with Section 312000 "Earth Moving."
 3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
 4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course in accordance with Section 321216 "Asphalt Paving."

- D. Traffic Controls: Comply with requirements of authorities having jurisdiction.
 - 1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
 - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- E. Parking: Provide temporary offsite parking areas for construction personnel.
- F. Storage and Staging: Use designated areas of Project site for storage and staging needs.
- G. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
 - 1. Identification Signs: Provide Project identification signs as indicated on Drawings.
 - 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
 - a. Provide temporary, directional signs for construction personnel and visitors.
 - 3. Maintain and touch up signs, so they are legible at all times.
- H. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- I. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."
- J. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
 - 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- K. Temporary Elevator Use: See Division 14 elevator Section for temporary use of new elevators.
- L. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- M. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
 - 1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
 - 1. Comply with work restrictions specified in Section 011000 "Summary."
- C. Temporary Erosion and Sedimentation Control: Comply with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Section 311000 "Site Clearing."
 - 1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
 - 2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 - 3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 - 4. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. Tree and Plant Protection: Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."
- F. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- G. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals, so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.
- H. Site Enclosure Fence: Prior to commencing earthwork, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.
 - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
 - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner.
- I. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.
- J. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

- K. Temporary Egress: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.
- L. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- M. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
 - 1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
 - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition in accordance with requirements of authorities having jurisdiction.
 - 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 - 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign, stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.6 MOISTURE AND MOLD CONTROL

- A. Moisture and Mold Protection: Protect stored materials and installed Work in accordance with Moisture and Mold Protection Plan.
- B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
 - 1. Protect porous materials from water damage.
 - 2. Protect stored and installed material from flowing or standing water.
 - 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 - 4. Remove standing water from decks.
 - 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
 - 1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 - 2. Keep interior spaces reasonably clean and protected from water damage.
 - 3. Periodically collect and remove waste containing cellulose or other organic matter.
 - 4. Discard or replace water-damaged material.

5. Do not install material that is wet.
6. Discard and replace stored or installed material that begins to grow mold.
7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.

D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:

1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
 - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for [48] <Insert time period> hours are considered defective and require replacing.
 - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for [48] <Insert time period> hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
 - c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within [48] <Insert time period> hours.

3.7 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.

2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

**SECTION 015010 – TEMPORARY FACILITIES AND CONTROLS – STATE FIELD OFFICE
FOR CAPITAL IMPROVEMENT PROJECTS**

PART 1 GENERAL

The Contractor shall furnish and maintain, at his cost and for the State’s exclusive use, the following:

1.1 STATE FIELD OFFICE

- A. Provide either a) one (1) prefabricated and completely finished temporary office trailer unit or b) an appropriate field office inside the existing building, based on approval by DGS Project Manager. Such field office will have lockable entrances and operable windows. Only the State shall have keys to this trailer. At such time as deemed necessary by the DGS Inspector, the State field office may be moved inside of the substantially complete building. However, all space requirements, specified equipment and services must remain intact.

1.2 SPACE REQUIREMENTS

- A. The Field Office shall have a minimum of 500 gross square feet of floor area.
- B. Provide running water, toilet room with flush water closet, lavatory and approved water drainage system, medicine cabinet, paper towels and toilet paper (including dispensers).
- C. Installation Schedule – Provide a complete Owner’s Field Office facility in a location on the site as coordinated with the owner. The office shall be setup and made ready for use promptly upon issuance of a Notice to Proceed (NTP) and at least seven (7) days prior to beginning any work on the contract.
- D. The Contractor shall provide weekly janitorial service to keep quarters of the State representatives clean and neat at all times and adequately stocked with supplies.
- E. Equipment:
 - 1. Electric Water Cooler and Water: Provide continuous delivery for the duration of the construction project of 5-gallon bottled water such as “Deer Park” or approved equal.
 - 2. Heating: Sized to provide a nominal 70 degrees F inside temperature under the ASHRAE winter outside design conditions applicable to the construction site location.
 - a. Provide distribution system sufficient for uniform heating and comfort.
 - 3. Ventilation: Mechanical type sufficient for comfort during the change between heating and cooling seasons.
 - 4. Air-conditioning: System sufficient to maintain a nominal 80 degrees F inside temperature under ASHRAE summer outside conditions applicable to the construction site location.
 - 5. Equipment Options: Provide the equivalent heating, ventilation, and air conditioning in a single combination unit or in other combinations.
 - 6. Electrical: Complete wiring system including service entrance per NFPA No. 70.
 - a. Provide one (1) duplex convenience outlet for each 150 square feet of floor space with four (4) duplex convenience outlets at a minimum. Provide additional outlets and circuits for water cooler, air conditioning, and heating units as required. Provide a minimum of one (1) smoke detector. Provide fluorescent lighting based on 3 watts per square foot uniform distribution. (Requirement - 40 fc illumination at work surfaces).

7. Portable Digital Wireless Phone: Phone shall be equal to the following:
 - a. Samsung Galaxy S21 Smartphone with Android Operating System or Apple iPhone 13 with iOS. This is a minimum standard and shall be met or exceeded.
 - b. Phone service provider shall be Verizon.
 - c. Provide Otterbox Defender protective case.
 - d. Phone service shall be provided for the duration of the project, which includes up to and beyond the completion of the punch list.
 - e. Total Quantity Required: Two (2)
 - f. Phones will become property of the State at the end of the project.
8. Office Copier: Multi-function with print, fax, copy, and scan to email functionality. For the duration of the project maintain/ provide maintenance for photocopier and provide ink cartridges and copy paper (8-1/2" x 11, 8-1/2" x 14, and 11" x 17") (i.e. - Konica Minolta, Canon, Kyocera, etc.).
9. Wall Mounted Smart TV: Provide and install one (1) 50" (minimum size) Smart TV on agreed upon wall location within the DGS trailer for the benefit of the project to display drawings and pictures during project meetings. Contractor shall supply the Smart TV, the wall mount, and any necessary cables (at the needed length) to connect to project laptops (i.e. HDMI, HDMI-Display, etc.) and install.
10. Computer, Tablet, Accessories and Printer:
 - a. Laptop Computer (Required)
 - 1) Total Quantity Required: Two (2)
 - 2) Dell Precision 5560 (or newer model)
 - a) Processor - Intel® Core™ i7-11850U Processor (8 core, 24 MB Cache, 2.5 GHz to 4.80 GHz, 45 W, vPro), or equivalent
 - b) Operating System – Windows 10 Pro or Latest Operating System – Professional
 - c) Video Card – NVIDIA T1200 w/ 4 GB
 - d) LCD – 15.6" UltraSharp FHD+, 1920 x 1200, AG, NT, w/ Prem Panel Guar, 100% sRGB, Low BL w/ IR Camera
 - e) Memory – 16 GB, 2 x 8 GB, DDR4, 3200MHz, Non-ECC, SODIMM
 - f) Hard Drive – M.2 5 2280 512 GB, Gen 3 PCIe x4 NVMe, SED Solid State Drive
 - g) Wireless – intel Dual Band Wireless AX201 2x2 + Bluetooth 5.2 vPro
 - h) Battery – 6 cell 86 Whr Lithium battery with Express Charge
 - i) Dell Thunderbolt Dock – WD19TBS
 - j) See accessories for additional items required for each laptop
 - k) Laptop specifications will be provided upon request
 - l) Warranty: Two-year warranty, parts, and service with two years of at-site service with 24-hour response.
 - b. Tablet (Required)
 - 1) Total Quantity Required: Two (2)
 - 2) Dell Latitude 7320 2-in-1 DTBL, XCTO (or newer model (preferred))
 - a) Processor – 11th Generation Intel © Core i7-1180G7 (4 Core, 12M cache, base 2.2Ghz, up to 4.63Ghz, vPro capable)
 - b) Operating System – Windows 10 Pro or latest
 - c) Memory – 16GB, LPDDR4X SDRAM, 4267 Mhz (on board)
 - d) Hard Drive – M.2 512GB PCIe NVMe Class 35 Solid State Drive
 - e) LCD – 13" 3:2 FHD+ (1920 x 1280) Touch, 500 nits Super Low Power, Low Blue Light, Gorilla Glass 6 DX, Mic

- f) Wireless – Intel© Wi-Fi 6 AX201 2x2 802.11ax 160MHz + Bluetooth 5.2 Wireless Card
- g) Mobile Broadband – Verizon (MBB VRZN)
- h) Camera – RGB IR Camera w/ Prox snsr (Front)
- 3) Shall include internet service sim card. Internet service provider shall be Verizon.
- 4) See Accessories for additional items required
- 5) Tablet specifications will be provided upon request
- 6) Warranty: Two-year warranty, parts, and service with two years of at-site service with 24-hour response.
- 7) Provide Dell Support Services – 4 year ProSupport Plan w/ Next Business Day Onsite Service; 2-year Extended Battery Service and 3-year Advanced Exchange Service
- 8) Dell Latitude Detachable Travel Keyboard
- 9) Dell Premium Active Pen
- 10) Dell Thunderbolt Dock – WD19TBS
- c. Surge Protectors
 - 1) Seven outlets
 - 2) Six-foot cord
 - 3) 2160 Joules
 - 4) One each for laptop computer
- d. Software
 - 1) Operating System = Most current Windows Pro Operating System; 64-bit
 - 2) Microsoft© Office 365 – Full version – Most current system
 - 3) If subscription is required; minimum of 2-year subscription
 - 4) Adobe Pro CC
 - 5) Scheduling Software – MS Project (minimum and compatible with MS Office365)
 - 6) McAfee Anti-Virus Protection
- e. ~~Computer~~ Laptop/ Tablet Accessories
 - 1) Dell Docking Stations
 - a) Provide Dell Thunderbolt Dock for tablets and laptops
 - 2) Dell Latitude 7320 Detachable Travel Keyboard (1 per tablet)
 - 3) Dell Stylus Pen for Dell Latitude 7200 2-in-1 (1 per tablet)
 - 4) Wireless mouse and keyboard for both systems – Laptop/ Tablet and/or PC
 - a) Logitech MK345 (or newer) wireless combo – full-sized keyboard and mouse
 - b) Detachable tablet keyboard for Dell Latitude 7200 2-in-1
 - 5) 1 – 24” External Monitor – Adjustable (U2422H)
 - 6) 1 – 24” External Monitor – Web Conferencing (C2422HE)
 - 7) 64GB Flash Drive
 - 8) Carrying Case for Laptop 17”
 - a) Include shoulder strap
 - 9) Carrying Case for Mobile Printer
 - 10) Protective cover for Tablet (i.e. – OtterBox)
 - 11) Carrying Case for Tablet (i.e. Amazon Basics 14-inch Tablet bag – Black)
- f. Desktop Printer – Wireless
 - 1) HP Printer (HP LaserJet M479-FDN – Preferred)
 - a) Color Multi-function Printer/Scanner/Copier/Fax
 - b) Automatic two-sided (Duplexing), printing, copying
 - 2) Printer cartridges and paper for the duration of the project
- g. Portable Printer

- 1) HP Officejet 250 Mobile All-in-One Printer (or newer model. Must be able to scan, print, and copy.)
- h. Warranty: Two-year warranty, parts and service with two years of at-site service with 24-hour response. All equipment shall be approved equal.
- i. General Note/ Requirement
 - 1) Above requirements for the equipment are a minimum standard and should be met or exceeded, and/or approved as an equal.
 - 2) Any deviation or substitutions to be submitted and will need approval by DGS. All equipment shall become property of DGS at the end of the project.
 - 3) Contractor shall provide a product submittal confirming all equipment specified complies with both quantity and identified requirements/specifications prior to purchase.
 - 4) The computer/laptop/tablet equipment procured shall have a purchased two-year warranty for parts and service and replacement with two years of at-sit service with 254-hour response.
11. First Aid Supplies: Comply with governing regulations
12. Hardhats: Provide hard hats (Qty. 5) that comply with OSHA Standards.
13. Safety Vest: Provide high visible safety vests (Qty. 5) that comply with ANSI standards.
14. Office supplies including but not limited to:
 - a. Trash cans (Qty. 2)
 - b. Boxes of file folders (Qty. 4) - File folders to be furnished for duration of the project.
 - c. Boxes of hanging file folders (Qty. 4) - Hanging file folders to be furnished for duration of the project
 - d. Standard stapler (Qty. 1)
 - e. 3-hole punch (Qty. 1)
 - f. 2-hole punch (Qty. 1)
 - g. Tape dispenser (Qty. 1) with tape (to be furnished for duration of the project)
 - h. Shredder – Crosscut
 - i. Unless otherwise stated, all office supplies shall become property of DGS at the end of the project.
15. Internet Service:
 - a. Internet service shall be provided for the duration of the project, which includes the duration of time needed to complete punch list after substantial completion.
 - b. Hard-wired WiFi router (802.11b/g/n) or wireless hot spot capable of supporting a minimum of 2 computers, with unlimited data, at a speed of at least 25Mbps.
 - c. Wireless (secured) Jetpack System for Owner shall have a minimum speed of 100 Mbps. Service provider shall be Verizon. Unless otherwise stated, the Wireless Jetpack shall become property of DGS at the end of the project.

F. Furnishings:

1. Furniture: Provide the following
 - a. 30"x 60" desk, flat top double pedestal. (Qty. 1)
 - b. Heavy-duty computer chairs (Qty. 2)
 - c. Table suitable for 12 people (Qty. 1)
 - d. Folding chairs (Qty. 12)
 - e. File cabinets, metal 4-drawer legal-size, 27" deep, with baked-on enamel finish. (Qty. 2) File cabinets shall have keyed locks. Provide keys to inspector.
 - f. Fireproof file cabinet, metal 4 drawer legal size 27" deep, heavy duty keyed lock, baked-on enamel finish. (Qty. 1) Cabinet should be securely mounted to the floor. Provide keys to inspector.

- g. Sample Shelves (Qty. 2 minimum): Ceiling-high units 30" deep, and minimum 3' wide. Close ends and backs with plywood sheet.
 - h. Adjustable Aluminum Plan Racks: Provide 1 unit with at least 10 sets of aluminum plan binders.
 - i. Shades: Provide standard fabric roller shades or metal slat Venetian blinds at all windows.
 - j. Fire Extinguisher: Provide ABC fire extinguisher, the number and extinguisher rating and location of which shall be in accordance with NFPA No.10.
- G. Maintenance:
- 1. The contractor will be responsible for the maintenance and/or repair of all items listed in this section for the duration of the contract. If an item cannot satisfactorily repaired, it shall be replaced by the contractor within two (2) working days.

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

(Not Used)

END OF SECTION 015010

SECTION 015639 - TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. The Work of this Section Includes: General protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.
- B. Related Requirements:
 - 1. Section 015000 "Temporary Facilities and Controls" for temporary site fencing.
 - 2. Section 311000 "Site Clearing" for removing existing trees and shrubs.

1.2 DEFINITIONS

- A. Caliper: Diameter of a trunk measured by a diameter tape or the average of the smallest and largest diameters at a height **6 inches (150 mm)** above the ground for trees up to and including **4-inch (100-mm)** size at this height and as measured at a height of **12 inches (300 mm)** above the ground for trees larger than **4-inch (100-mm)** size.
- B. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.
- C. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.
- D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and locations of protection-zone fencing and signage, showing relation of equipment-movement routes and material storage locations with protection zones.
 - 2. Detail fabrication and assembly of protection-zone fencing and signage.
 - 3. Indicate extent of trenching by hand or with air spade within protection zones.

1.4 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.
 - 1. Use sufficiently detailed photographs or video recordings.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.
- B. Quality-control program.

1.5 FIELD CONDITIONS

- A. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Moving or parking vehicles or equipment.
 - 3. Foot traffic.
 - 4. Erection of sheds or structures.
 - 5. Impoundment of water.
 - 6. Excavation or other digging unless otherwise indicated.
 - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- B. Do not direct vehicle or equipment exhaust toward protection zones.
- C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Backfill Soil: Stockpiled soil mixed with planting soil of suitable moisture content and granular texture for placing around tree; free of stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.
 - 1. Mixture: Well-blended mix of two parts stockpiled soil to one part planting soil.
- B. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:
 - 1. Type: Shredded hardwood.
 - 2. Size Range: 3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum.
 - 3. Color: Natural.

- C. Protection-Zone Fencing: Fencing fixed in position and meeting one of the following requirements:
 - 1. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with **2-inch (50-mm)** maximum opening in pattern and weighing a minimum of **0.4 lb/ft. (0.6 kg/m)**; remaining flexible from **minus 60 to plus 200 deg F (minus 16 to plus 93 deg C)**; inert to most chemicals and acids; minimum tensile yield strength of **2000 psi (13.8 MPa)** and ultimate tensile strength of **2680 psi (18.5 MPa)**; secured with plastic bands or galvanized-steel or stainless steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than **96 inches (2400 mm)** apart.
 - a. Height: **48 inches (1200 mm)**.
 - b. Color: High-visibility orange, nonfading.
- D. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- B. Prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

3.2 PREPARATION

- A. Locate and clearly identify trees, shrubs, and other vegetation to remain. Flag each tree trunk at **54 inches (1372 mm)** above the ground.
- B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.
- C. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated. Do not exceed indicated thickness of mulch.
 - 1. Apply **2-inch (50-mm)** uniform thickness of organic mulch unless otherwise indicated. Do not place mulch within **6 inches (150 mm)** of tree trunks.

3.3 PROTECTION ZONES

- A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people from easily entering protected areas except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.
- B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Architect. Install one sign spaced approximately every 20 feet (6 m) on protection-zone fencing, but no fewer than four signs with each facing a different direction.
- C. Maintain protection zones free of weeds and trash.
- D. Maintain protection-zone fencing and signage in good condition as acceptable to Architect and remove when construction operations are complete and equipment has been removed from the site.
 - 1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
 - 2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.4 EXCAVATION

- A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Section 312000 "Earth Moving" unless otherwise indicated.
- B. Trenching within Protection Zones: Where utility trenches are required within protection zones, excavate under or around tree roots by hand or with air spade, or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots.
- C. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches (75 mm) back from new construction and as required for root pruning.
- D. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

3.5 ROOT PRUNING

- A. Prune tree roots that are affected by temporary and permanent construction. Prune roots as follows:
 - 1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
 - 2. Cut Ends: Do not paint cut root ends.
 - 3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
 - 4. Cover exposed roots with burlap and water regularly.
 - 5. Backfill as soon as possible according to requirements in Section 312000 "Earth Moving."

- B. Root Pruning within Protection Zone: Clear and excavate by hand or with air spade to the depth of the required excavation to minimize damage to tree root systems. If excavating by hand, use narrow-tine spading forks to comb soil to expose roots. Cleanly cut roots as close to excavation as possible.

3.6 REGRADING

- A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

- B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.
 - 1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.

- C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

- D. Minor Fill within Protection Zone: Where existing grade is **2 inches (50 mm)** or less below elevation of finish grade, fill with backfill soil. Place backfill soil in a single uncompacted layer and hand grade to required finish elevations.

3.7 REPAIR AND REPLACEMENT

- A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or to be relocated that are damaged by construction operations, in a manner approved by Architect.
 - 1. Submit details of proposed pruning and repairs.
 - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours according to arborist's written instructions.

3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.
- B. Trees: Remove and replace trees indicated to remain that are more than 66 percent dead or in an unhealthy condition or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.
1. Small Trees: Provide new trees of same size and species as those being replaced for each tree that measures **6 inches (150 mm)** or smaller in caliper size.
 2. Plant and maintain new trees as specified in Section 329300 "Plants."
- C. Excess Mulch: Rake mulched area within protection zones, being careful not to injure roots. Rake to loosen and remove mulch that exceeds a **2-inch (50-mm)** uniform thickness to remain.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove excess excavated material, displaced trees, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 015639

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for Contractor requirements related to Owner-furnished products.
 - 2. Section 012100 "Allowances" for products selected under an allowance.
 - 3. Section 012300 "Alternates" for products selected under an alternate.
 - 4. Section 012500 "Substitution Procedures" for requests for substitutions.
 - 5. Section 014200 "References" for applicable industry standards for products specified.
 - 6. Section 01770 "Closeout Procedures" for submitting warranties.

1.3 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products, unless indicated otherwise.
 - 3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in Part 2 "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.
 - 1. Evaluation of Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification. Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.
- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.
- D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:
 - 1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
 - 2. Data indicating compliance with the requirements specified in Part 2 "Comparable Products" Article.
- E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."
- F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

1.4 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
- B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.

1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
2. Equipment Nameplates: Provide a permanent nameplate on each item of service- or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.
3. See individual identification Sections in Divisions 21, 22, 23, and 26 for additional equipment identification requirements.

1.5 COORDINATION

- A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 4. Inspect products on delivery to determine compliance with the Contract Documents and that products are undamaged and properly protected.
- C. Storage:
 1. Provide a secure location and enclosure at Project site for storage of materials and equipment.
 2. Store products to allow for inspection and measurement of quantity or counting of units.
 3. Store materials in a manner that will not endanger Project structure.

4. Store products that are subject to damage by the elements under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation and with adequate protection from wind.
5. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of the Owner or endorsed by manufacturer to Owner.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of the Owner or endorsed by manufacturer to Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.

2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
 - a. Submit additional documentation required by Architect in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by the Architect, whose determination is final.

B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."
2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."
3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
 - a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."
4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements.
 - a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."

- b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.
 5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
 - a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."
 6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.
 - a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
 - b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.
 7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
 - a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.
- C. Visual Matching Specification: Where Specifications require the phrase "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or a similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.
- E. Sustainable Product Selection: Where Specifications require product to meet sustainable product characteristics, select products complying with indicated requirements. Comply with requirements in Division 01 sustainability requirements Section and individual Specification Sections.

1. Select products for which sustainable design documentation submittals are available from manufacturer.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with the following requirements:
 1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes, such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects, with project names and addresses and names and addresses of architects and owners, if requested.
 5. Samples, if requested.
- B. Architect's Action on Comparable Products Submittal: If necessary, Architect will request additional information or documentation for evaluation, as specified in Section 013300 "Submittal Procedures."
 1. Form of Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
 2. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- C. Submittal Requirements, Two-Step Process: Approval by the Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering and surveying.
 - 3. Installation of the Work.
 - 4. Cutting and patching.
 - 5. Progress cleaning.
 - 6. Starting and adjusting.
 - 7. Protection of installed construction.
 - 8. Correction of the Work.

- B. Related Requirements:
 - 1. Section 013300 "Submittal Procedures" for submitting surveys.
 - 2. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.
 - 3. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.
 - 4. Section 078413 "Penetration Firestopping" for patching penetrations in fire-rated construction.

1.2 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.

- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For land surveyor.

- B. Certified Surveys: Submit two copies signed by land surveyor.

- C. Certificates: Submit certificate signed by land surveyor, certifying that location and elevation of improvements comply with requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Final Property Survey: Submit 10 copies showing the Work performed and record survey data.

1.5 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. Professional Engineer Qualifications: Refer to Section 014000 "Quality Requirements."
- C. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
 - 1. Construction Elements: Do not cut and patch construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
 - 2. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with requirements specified in other Sections.
 - 1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with sustainable design requirements.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials. Use materials that are not considered hazardous.

- C. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
 - 1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
 - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - 1. Description of the Work, including Specification Section number and paragraph, and Drawing sheet number and detail, where applicable.
 - 2. List of detrimental conditions, including substrates.
 - 3. List of unacceptable installation tolerances.
 - 4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect in accordance with requirements in Section 013100 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Architect promptly.
- B. Engage a land surveyor experienced in laying out the Work, using the following accepted surveying practices:
 - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 - 2. Establish limits on use of Project site.
 - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 4. Inform installers of lines and levels to which they must comply.
 - 5. Check the location, level and plumb, of every major element as the Work progresses.
 - 6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
 - 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
 - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- E. Final Property Survey: Engage a land surveyor to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
 - 1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.

3.5 INSTALLATION

- A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb, and make horizontal work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 4. Maintain minimum headroom clearance of **96 inches (2440 mm)** in occupied spaces and **90 inches (2300 mm)** in unoccupied spaces, unless otherwise indicated on Drawings.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure satisfactory results as judged by Architect. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.
- F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.
1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 2. Allow for building movement, including thermal expansion and contraction.
 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Architect. Fit exposed connections together to form hairline joints.

3.6 CUTTING AND PATCHING

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of Work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching in accordance with requirements in Section 011000 "Summary."
- F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.
- G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 - 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 - 6. Proceed with patching after construction operations requiring cutting are complete.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by Architect. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 3. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 COORDINATION OF OWNER'S PORTION OF THE WORK

- A. Site Access: Provide access to Project site for Owner's construction personnel.
1. Provide temporary facilities required for Owner-furnished, Contractor-installed products.
 2. Refer to Section 011000 "Summary" for other requirements for Owner-furnished, Contractor-installed products.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.
1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 2. Preinstallation Conferences: Include Owner's construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.8 PROGRESS CLEANING

- A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Use containers intended for holding waste materials of type to be stored.

4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
 - C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
 1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
 - D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
 - E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
 - F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
 - G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal."
 - H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
 - I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
 - J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.
- 3.9 STARTING AND ADJUSTING
- A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."
 - B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
 - C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.10 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.
- C. Comply with manufacturer's written instructions for temperature and relative humidity.

3.11 CORRECTION OF THE WORK

- A. Repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates and finishes.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.
- C. Restore permanent facilities used during construction to their specified condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 017300

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous demolition and construction waste.
 - 2. Recycling nonhazardous demolition and construction waste.
 - 3. Disposing of nonhazardous demolition and construction waste.
- B. Related Requirements:
 - 1. Section 024119 "Selective Structure Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements.

1.2 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling of **75 percent** by weight of total nonhazardous solid waste generated by the Work in at least **four material streams**. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials.

1.4 SUBMITTALS

- A. Waste Management Plan: Submit plan within 30 days of date established for commencement of the Work.
- B. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit USGBC's LEED v4 Construction and Demolition Waste Calculator.

- C. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work using USGBC's LEED v4 Construction and Demolition Waste Calculator.
- D. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- E. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- F. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- G. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- H. Qualification Data: For waste management coordinator.

1.5 QUALITY ASSURANCE

- A. Waste Management Coordinator Qualifications: LEED-Accredited Professional, certified by USGBC, as waste management coordinator. Waste management coordinator may also serve as LEED coordinator.
- B. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

1.6 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing, and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
 1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
 2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
 3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.

5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
 1. Distribute waste management plan to everyone concerned within three days of submittal return.
 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
 2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

- A. Salvaged Items for Reuse in the Work:
 1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until installation.
 4. Protect items from damage during transport and storage.
 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- B. Salvaged Items for Sale and Donation: Not permitted on Project site.
- C. Salvaged Items for Owner's Use:
 1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.

4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Owner .
- C. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
 1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
 4. Store components off the ground and protect from the weather.
 5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor.

3.4 RECYCLING DEMOLITION WASTE

- A. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.
- B. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
- C. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
 1. Clean and stack undamaged, whole masonry units on wood pallets.
- D. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- E. Metals: Separate metals by type.
 1. Structural Steel: Stack members according to size, type of member, and length.
 2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
- F. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
- G. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
- H. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.
- I. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.

1. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.
- J. Carpet Tile: Remove debris, trash, and adhesive.
 1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.
- K. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
- L. Conduit: Reduce conduit to straight lengths and store by type and size.

3.5 RECYCLING CONSTRUCTION WASTE

- A. Packaging:
 1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 2. Polystyrene Packaging: Separate and bag materials.
 3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
 4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
- B. Wood Materials:
 1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
 2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
- C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.
 1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

3.6 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.
- C. Disposal: Remove waste materials from Owner's property and legally dispose of them.

END OF SECTION

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.
- B. Related Requirements:
 - 1. Section 012900 "Payment Procedures" for requirements for Applications for Payment for Substantial Completion and Final Completion.
 - 2. Section 013233 "Photographic Documentation" for submitting Final Completion construction photographic documentation.
 - 3. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
 - 4. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 5. Section 017900 "Demonstration and Training" for requirements to train the Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.3 DEFINITIONS

- A. List of Incomplete Items: Contractor-prepared list of items to be completed or corrected, prepared for the Architect's use prior to Architect's inspection, to determine if the Work is substantially complete.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of cleaning agent.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

- C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.5 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest-control inspection.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items required by other Sections.

1.7 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
 - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Owner's signature for receipt of submittals.
 - 5. Submit testing, adjusting, and balancing records.
 - 6. Submit sustainable design submittals not previously submitted.
 - 7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Advise Owner of pending insurance changeover requirements.
 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 3. Complete startup and testing of systems and equipment.
 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
 6. Advise Owner of changeover in utility services.
 7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 9. Complete final cleaning requirements.
 10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for Final Completion.

1.8 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:
1. Submit a final Application for Payment in accordance with Section 012900 "Payment Procedures."
 2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Submit pest-control final inspection report.
 5. Submit Final Completion photographic documentation.

- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 - 1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.9 LIST OF INCOMPLETE ITEMS

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
 - 1. Organize list of spaces in sequential order, starting with exterior areas first, listed by room or space number.
 - 2. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
 - 3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Page number.
 - 4. Submit list of incomplete items in the following format:
 - a. MS Excel Electronic File: Architect will return annotated file.

1.10 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

- D. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
 - 1. Submit on digital media acceptable to Architect.
- E. Warranties in Paper Form:
 - 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive **8-1/2-by-11-inch (215-by-280-mm)** paper.
 - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- F. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
 - 1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

- a. Clean Project site of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - g. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - h. Clean flooring, removing debris, dirt, and staining; clean according to manufacturer's recommendations.
 - i. Vacuum and mop concrete.
 - j. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 - k. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - l. Remove labels that are not permanent.
 - m. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - p. Clean ducts, blowers, and coils.
 - 1) Clean HVAC system in compliance with NADCA ACR. Provide written report on completion of cleaning.
 - q. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
 - r. Clean strainers.
 - s. Leave Project clean and ready for occupancy.
- C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.
- D. Construction Waste Disposal: Comply with waste-disposal requirements in Section 017419 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations required by Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

Maryland State Police
Tactical Administration Center
PA-745-210-001

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory manuals.
 - 2. Emergency manuals.
 - 3. Systems and equipment operation manuals.
 - 4. Systems and equipment maintenance manuals.
 - 5. Product maintenance manuals.
- B. Related Requirements:
 - 1. Section 011200 "Multiple Contract Summary" for coordinating operation and maintenance manuals covering the Work of multiple contracts.
 - 2. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
 - 3. Section 019113 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect[**and Commissioning Authority**] will comment on whether content of operation and maintenance submittals is acceptable.

2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
1. Submit on digital media acceptable to Architect. Enable reviewer comments on draft submittals.
- C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect and Commissioning Authority will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect and Commissioning Authority will return copy with comments.
1. Correct or revise each manual to comply with Architect's and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's and Commissioning Authority's comments and prior to commencing demonstration and training.
- E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
1. Title page.
 2. Table of contents.
 3. Manual contents.

- B. Title Page: Include the following information:
1. Subject matter included in manual.
 2. Name and address of Project.
 3. Name and address of Owner.
 4. Date of submittal.
 5. Name and contact information for Contractor.
 6. Name and contact information for Construction Manager.
 7. Name and contact information for Architect.
 8. Name and contact information for Commissioning Authority.
 9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 10. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.7 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
 2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
 3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.8 EMERGENCY MANUALS

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Content: Organize manual into a separate section for each of the following:
 - 1. Type of emergency.
 - 2. Emergency instructions.
 - 3. Emergency procedures.
- C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
 - 1. Fire.
 - 2. Flood.
 - 3. Gas leak.
 - 4. Water leak.
 - 5. Power failure.
 - 6. Water outage.
 - 7. System, subsystem, or equipment failure.
 - 8. Chemical release or spill.
- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:
 - 1. Instructions on stopping.
 - 2. Shutdown instructions for each type of emergency.
 - 3. Operating instructions for conditions outside normal operating limits.
 - 4. Required sequences for electric or electronic systems.
 - 5. Special operating instructions and procedures.

1.9 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Performance and design criteria if Contractor has delegated design responsibility.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
1. Product name and model number. Use designations for products indicated on Contract Documents.
 2. Manufacturer's name.
 3. Equipment identification with serial number of each component.
 4. Equipment function.
 5. Operating characteristics.
 6. Limiting conditions.
 7. Performance curves.
 8. Engineering data and tests.
 9. Complete nomenclature and number of replacement parts.
- D. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
 2. Equipment or system break-in procedures.
 3. Routine and normal operating instructions.
 4. Regulation and control procedures.
 5. Instructions on stopping.
 6. Normal shutdown instructions.
 7. Seasonal and weekend operating instructions.
 8. Required sequences for electric or electronic systems.
 9. Special operating instructions and procedures.
- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.10 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.
- C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.
- E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.
 - 6. Demonstration and training video recording, if available.

- F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.
- J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of maintenance manuals.

1.11 PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.

5. Reordering information for specially manufactured products.
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
 2. Types of cleaning agents to be used and methods of cleaning.
 3. List of cleaning agents and methods of cleaning detrimental to product.
 4. Schedule for routine cleaning and maintenance.
 5. Repair instructions.
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.
 - 2. Record specifications.
 - 3. Record Product Data.
 - 4. Miscellaneous record submittals.
- B. Related Requirements:
 - 1. Section 017700 "Closeout Procedures" for general closeout procedures.
 - 2. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set(s) of marked-up record prints.
 - 2. Number of Copies: Submit copies of Record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit PDF electronic files of scanned record prints and one set(s) of file prints.
 - 2) Submit Record Digital Data Files and one set(s) of plots.
 - 3) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit one paper-copy set(s) of marked-up record prints.
 - 2) Submit Record Digital Data Files and three set(s) of Record Digital Data File plots.
 - 3) Plot each drawing file, whether or not changes and additional information were recorded.

- B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and Contract modifications.
- C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
 - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.
- D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.
- E. Reports: Submit written report weekly indicating items incorporated into Project Record Documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

1.4 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding photographic documentation.
 - 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect[**and Construction Manager**]. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: Same digital data software program, version, and operating system as for the original Contract Drawings.
 2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 3. Refer instances of uncertainty to Architect for resolution.
 4. Architect will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.
 - a. See Section 013100 "Project Management and Coordination" for requirements related to use of Architect's digital data files.
 - b. Architect will provide data file layer information. Record markups in separate layers.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file with comment function enabled.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect.
 - e. Name of Contractor.

1.5 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation, where installation varies from that indicated in Specifications, addenda, and Contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
5. Note related Change Orders, Record Product Data, and Record Drawings where applicable.

B. Format: Submit record specifications as annotated PDF electronic file.

1.6 RECORD PRODUCT DATA

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and revisions to Project Record Documents as they occur; do not wait until end of Project.

B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.

C. Format: Submit Record Product Data as annotated PDF electronic file.

1. Include Record Product Data directory organized by Specification Section number and title, electronically linked to each item of Record Product Data.

1.7 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as PDF electronic file.

1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

Maryland State Police
Tactical Administration Center
PA-745-210-001

1.8 MAINTENANCE OF RECORD DOCUMENTS

- A. Maintenance of Record Documents: Store Record Documents in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017839

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes general requirements and procedures for compliance with certain prerequisites and credits needed for Project to obtain "LEED Version 4 for Building Design and Construction" (LEED v4 BD+C) **Silver** certification based on USGBC's LEED v4 BD+C and certain credits as indicated based on USGBC's LEED v4.1 BD+C.
 - 1. Specific requirements for LEED are also included in other Sections.
 - 2. Some LEED prerequisites and credits needed to obtain LEED certification depend on product selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
 - 3. A copy of the LEED Project checklist is attached at the end of this Section for information only.
 - a. Some LEED prerequisites and credits needed to obtain the indicated LEED certification depend on aspects of Project that are not part of the Work of the Contract.
 - 4. Definitions included in the "LEED Version 4 for Building Design and Construction" (LEED v4 BD+C) Reference Guide and online amendments apply to this Section.
- B. Related Requirements:
 - 1. Section 01 32 33, "Photographic Documentation."
 - 2. Section 01 33 00, "Submittal Procedures."
 - 3. Section 01 50 00, "Temporary Facilities and Controls" for temporary heating and cooling requirements.
 - 4. Section 01 81 13.01, "Indoor Air Quality Management."
 - 5. Section 01 74 19, "Construction Waste Management and Disposal."
 - 6. Section 01 78 23, "Operation and Maintenance Data."
 - 7. Section 01 78 39, "LEED Systems Manual."
 - 8. Section 01 91 13, "General Commissioning Requirements."
 - 9. Divisions 02 through 49 Sections for LEED requirements specific to the work of each of these Sections. Requirements may or may not include reference to LEED.

1.03 DEFINITIONS

- A. **Bio-Based Materials:** Materials that meet the Sustainable Agriculture Network's Sustainable Agriculture Standard. Bio-based raw materials shall be tested using ASTM D 6866 and be legally harvested, as defined by the exporting and receiving country.
- B. **CDPH Standard Method v. 1.2-2017:** California Department of Public Health (CDPH) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, v. 1.2-2017, for the emissions testing and requirements of products and materials.
- C. **Chain-of-Custody (COC):** A procedure that tracks a product from the point of harvest or extraction to its end use, including all successive stage of processing, transformation, manufacturing, a distribution.
- D. **Chain-of-Custody Certificates:** Certificates signed by manufacturers and fabricators certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001.
- E. **Composite Wood and Agrifiber:** Products made of wood particles and/or plant material pressed and bonded with adhesive or resin such as particleboard, medium density fiberboard (MDF), plywood, wheatboard, strawboard, panel substrates, and door cores.
- F. **Corporate Sustainability Report:** A third-party verified report that outlines the environmental impacts of extraction operations and activities associated with the manufacturer's product and the product's supply chain.
- G. **Environmental Product Declaration (EPD):** An independently verified report based on life-cycle assessment studies that have been conducted according to a set of common rules for each product category and peer-reviewed.
 - 1. **Product-Specific Declaration:** A product with a publicly available, critically reviewed life-cycle assessment conforming to ISO 14044 that has at least a cradle to gate scope.
 - 2. **Industry-Wide (Generic) EPD:** Provide products with third-party certification (Type III), including external verification, in which the manufacturer is explicitly recognized as a participant by the program operator. EPD must conform to ISO 14025, 14040, 14044, and EN 15804 or ISO 21930 and have at least a cradle to gate scope.
 - 3. **Product-Specific Type III EPD:** A product with a third-party certification, including external verification, in which the manufacturer is explicitly recognized by the program operator. EPD must conform to ISO 14025, 14040, 14044, **and** EN 15804 or ISO 21930 and have at least a cradle to gate scope.
- H. **Extended Producer Responsibility (EPR):** Measures undertaken by the maker of a product to accept its own and sometimes other manufacturers' products as postconsumer waste at the end of the products' useful life.
- I. **Health Product Declaration Open Standard (HPD):** A standard format for reporting product content and associated health information for building products and materials.

- J. Indoor Air Quality (IAQ) Management Plan: Plan developed by the Contractor to provide a healthy indoor environment for workers and building occupants during construction. Plan must meet or exceed the recommendations of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) "IAQ Guidelines for Occupied Buildings Under Construction."
- K. Leadership Extraction Practices: Products that meet at least one of the responsible extraction criteria, which include: extended producer responsibility; bio-based materials; FSC wood products; materials reuse; recycled content; and other USGBC approved programs.
- L. Material Cost: The dollar value of materials being provided to the site, after Contractor mark-ups, including transportation costs, taxes, fees, and shop labor, but excluding field equipment and field labor costs.
- M. Materials Reuse: Reuse includes salvaged, refurbished, or reused products.
- N. Multi-Attribute Optimization: Third party certified products that demonstrate impact reduction below industry average in at least three of the following six categories: global warming potential; stratospheric ozone depletion; acidification; eutrophication; tropospheric ozone creation; nonrenewable resource depletion.
- O. Recycled Content: Recycled content is the sum of postconsumer recycled content plus one-half the preconsumer recycled content, based on cost.
 - 1. "Postconsumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
 - 2. "Preconsumer" material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials, such as rework, regrind, or scrap, generated in a process and capable of being reclaimed within the same process that generated it.
- P. Regional Materials: Materials that are extracted, harvested, recovered, and manufactured within a radius of **100 miles** from the Project site.
- Q. Volatile Organic Compounds (VOC) Emissions Test: Refer to CDPH Standard Method v. 1.2-2017 definition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Work of this project includes completed building and application for LEED certification. Work is not complete until Owner has accepted USGBC's final review of LEED certification.
 - 1. Provide documentation required by LEED and LEED review.
- B. Provide materials and procedures necessary to obtain LEED prerequisites and credits required in this Section. Other Sections may specify requirements that contribute to LEED prerequisites and credits. Refer to other sections for additional materials and procedures necessary to obtain LEED prerequisites and credits.

- C. Respond to questions and requests for additional information from Architect and the USGBC regarding LEED credits until the USGBC has made its determination on the project's LEED certification application.
- D. LEED Online Submittals: Upload LEED documentation submittal data directly to USGBC project "LEED Online" website or to the Project's LEED Administrator as applicable. Complete online forms at least monthly and as necessary to document LEED credits for submittals required in this Section.
- E. LEED Conference: Schedule and conduct a conference at a time convenient to Owner and Architect within 21 days prior to commencement of the work. Advise Architect, Owner's Commissioning Authority[, and **Owner's Project Manager**] of scheduled meeting dates.
 - 1. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, [**Owner's Project Manager**,] Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 2. Agenda: LEED goals for the project, Contractor's action plans, and discussion of targeted LEED Prerequisites and Credits, Communication Pathways, Submittal Process, Record Keeping & Reporting.
 - 3. Minutes: Record and distribute minutes to attendees and other entities with responsibilities for obtaining LEED Credits.

1.05 ACTION SUBMITTALS

- A. General: Submit additional LEED submittals required by other Specification Sections.
 - 1. Submit each LEED submittal simultaneously with applicable product submittal.
- B. LEED Documentation Submittals:
 - 1. General, LEED Materials Submittal Cover Sheet: Project submittals must be accompanied by a completed LEED Submittal Cover Sheet. Submittal packages must also include highlighted documentation supporting the sustainability claims made on the LEED Submittal Cover Sheet.
 - a. Provide location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material.
 - 2. EAp3, Building-Level Energy Metering: Product data for meters, sensors, and data collection system used to provide continuous metering of building energy-consumption performance.
 - 3. MRp2/MRc5, Construction and Demolition Waste Management: Comply with submittal requirements of Section 01 74 19 "Construction Waste Management and Disposal."
 - 4. MRc2, Building Product Disclosure and Optimization: Environmental Product Declarations, Option 1 complying with LEED requirements.
 - a. Environmental Product Declarations (EPDs) for 20 products from at least 5 different manufacturers that meet LEED requirements for disclosure criteria.

5. MRC3, Building Product Disclosure and Optimization, Sourcing of Raw Materials: Option 2, Leadership Extraction Practices.
 - a. Extended Producer Responsibility: Product data and certification letter from product manufacturers, indicating participation in an extended producer responsibility program and statement of costs.
 - b. Bio-Based Materials: Product data and certification for bio-based materials, indicating that they comply with requirements. Include statement of costs.
 - c. Certified Wood: Product data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
 - d. Materials Reuse: Receipts for salvaged and refurbished materials used for Project, indicating sources and costs.
 - e. Recycled Content: Product data and certification letter from product manufacturers, indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. Include statement of costs.

6. MRC4, Building Product Disclosure and Optimization, Material Ingredients: Option 1, Material Ingredient Reporting.
 - a. Material ingredient reports for 20 products from at least 5 different manufacturers that comply with LEED requirements for material ingredient reporting, including but not limited to the following:
 - 1) Manufacturer Inventory.
 - 2) Health Product Declaration.
 - 3) Cradle to Cradle certifications.
 - 4) DECLARE product labels.

7. EQp2/EQc3/EQc4, Indoor Air Quality: Comply with submittal requirements of Section 01 81 13.01, "Indoor Air Quality Management."

8. EQc2, Low-Emitting Materials: Product data, indicating VOC content and emissions testing documents showing compliance with requirements for low-emitting materials, for the following materials:
 - a. Paints and coatings.
 - b. Adhesives and sealants.
 - c. Flooring.
 - d. Products containing composite wood or agrifiber products or wood glues.
 - e. Ceilings, walls, thermal, and acoustic insulation.
 - f. Furniture (optional)

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For LEED coordinator.
- B. Project Materials Cost Data: Provide statement indicating total cost for materials used for Project. Costs exclude labor, overhead, and profit. Include taxes and delivery or freight charges. Include breakout of costs for the following categories of items:
 1. Plumbing.

2. Mechanical.
 3. Electrical.
- C. Sustainable Design Action Plans: Provide preliminary submittals within 30 days of date established for commencement of the Work, indicating how the following requirements will be met:
1. List of proposed products with Environmental Product Declarations.
 2. List of proposed products complying with requirements for multi-attribute optimization.
 3. List of proposed products complying with requirements for raw material and source extraction reporting.
 4. List of proposed products complying with requirements for material ingredient reporting.
 5. List of proposed products complying with requirements for material ingredient optimization.
 6. List of proposed products complying with requirements for product manufacturer supply chain optimization.
 7. Waste management plan complying with Section 017419 "Construction Waste Management and Disposal."
 8. Construction IAQ management plan.
- D. Sustainable Design Progress Reports: Concurrent with each Application for Payment, but not less than monthly, submit reports comparing actual construction and purchasing activities with sustainable design action plans.

1.7 QUALITY ASSURANCE

- A. LEED Coordinator: Engage an experienced LEED-Accredited Professional who has completed at least one LEED v4 BD+C project to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

- A. Provide products and procedures necessary to obtain LEED credits required in this Section. Although other Sections may specify some requirements that contribute to LEED credits, the Contractor shall determine additional materials and procedures necessary to obtain LEED credits indicated. Contractor to determine a combination of credit options best suited for achieving credits required.
1. Exclusions: Special equipment, such as elevators, escalators, process equipment, and fire suppression systems, is excluded from the credit calculations. Also excluded are products purchased for temporary use on the project, like formwork for concrete.

2.02 BUILDING PRODUCT DISCLOSURE AND OPTIMIZATION

- A. MRc2, Building Product Disclosure and Optimization, Environmental Product Declarations (EPD): Option 1. Provide at least 20 permanently installed products (sourced from at least 5 different manufacturers) which meet one of the disclosure criteria:
1. Product-Specific Declaration: Valued as one whole product.
 2. Industry-Wide (Generic) EPD: Valued as one whole product.
 3. Product-Specific Type III EPD: Valued as 1.5 products.
- B. MRc3, Building Product Disclosure and Optimization, Sourcing of Raw Materials: Option 2, Leadership Extraction Practices. Provide products that meet at least one of the responsible extraction criteria below for at least 20% for 1 point or 40% for 2 points, by cost, of the total value of permanently installed building products in the project:
1. Extended producer responsibility program.
 2. Bio-based materials.
 3. Certified Wood: Wood-based materials include, but are not limited to, the following materials when made from wood, engineered wood products, or wood-based panel products:
 - a. Rough carpentry.
 - b. Miscellaneous carpentry.
 - c. Heavy timber construction.
 - d. Wood decking.
 - e. Metal-plate-connected wood trusses.
 - f. Structural glued-laminated timber.
 - g. Finish carpentry.
 - h. Architectural woodwork.
 - i. Wood paneling.
 - j. Wood veneer wall covering.
 - k. Wood flooring.
 - l. Wood lockers.
 - m. Wood cabinets.
 4. Materials Reuse: The following materials may be salvaged, refurbished, or reused materials:
 - a. **<Insert list of materials>.**
 5. Recycled content.
 - a. Exceptions: Do not include furniture, fire protection, operational plumbing, operational mechanical, and operational electrical components, and specialty items, such as elevators and equipment, in the calculation.
- C. MRc4, Building Product Disclosure and Optimization, Material Ingredients: Option 1, Material Ingredient Reporting.
1. Use at least 20 different permanently installed products from at least five different manufacturers that use any of the following programs to demonstrate the chemical inventory of the product to at least **0.1% (1000 ppm)**, which meet one of the following disclosure criteria:

- a. Manufacturer Inventory.
- b. Health Product Declarations (HPDs).
- c. Cradle to Cradle (C2C) certifications.
- d. Declare product labels.

2.03 LOW-EMITTING MATERIALS

A. EQc2, Low-Emitting Materials, General Emissions Requirements: Products must demonstrate they have been tested and determined compliant in accordance with California Department of Public Health, (CDHP), Standard Method v. 1.2-2017, using the applicable exposure scenario. Manufacturer’s documentation demonstrating compliance must state the range of total VOCs (tVOC) after 14 days measured as specified in the CDPH Standard Method v1.2 as follows:

- 1. 0.5mg/m³ or less,
- 2. between 0.5 and 5.0 mg/m³ or,
- 3. 0.50 mg/m³ or more.

B. EQc2, Low-Emitting Materials, Paints and Coatings: For field applications that are inside the weatherproofing system, use paints and coatings that comply with the limits for VOC content when calculated according to the California Air Resources Board (CARB) 2007, Suggested Control Measure (SCM) for Architectural Coatings, or the South Coast Air Quality Management District (SCAQMD) Rule 1113, effective February 5, 2016.

Product Type:	Allowable VOC Content (g/L):
Bond Breaker	350
Clear wood finishes - Varnish	275
Clear wood finishes – Sanding Sealer	275
Clear wood finishes - Lacquer	275
Colorant – Architectural Coatings, excluding IM coatings	50
Colorant – Solvent Based IM	600
Colorant - Waterborne IM	50
Concrete – Curing compounds	100
Concrete – Curing compounds for roadways & bridges	350
Concrete surface retarder	50
Driveway Sealer	50
Dry-fog coatings	50
Faux finishing coatings - Clear topcoat	100
Faux finishing coatings – Decorative Coatings	350
Faux finishing coatings - Glazes	350
Faux finishing coatings - Japan	350
Faux finishing coatings – Trowel applied coatings	50
Fire-proof coatings	150
Flats	50
Floor coatings	50
Form release compounds	100
Graphic arts (sign) coatings	150

Product Type:	Allowable VOC Content (g/L):
Industrial maintenance coatings	100
Industrial maintenance coatings – High temperature IM coatings	420
Industrial maintenance coatings – Non-sacrificial anti-graffiti coatings	100
Industrial maintenance coatings – Zinc rich IM primers	100
Magnesite cement coatings	450
Mastic coatings	100
Metallic pigmented coatings	150
Multi-color coatings	250
Non-flat coatings	50
Pre-treatment wash primers	420
Primers, sealers and undercoaters	100
Reactive penetrating sealers	350
Recycled coatings	250
Roof coatings	50
Roof coatings, aluminum	100
Roof primers, bituminous	350
Rust preventative coatings	100
Stone consolidant	450
Sacrificial anti-graffiti coatings	50
Shellac- Clear	730
Shellac – Pigmented	550
Specialty primers	100
Stains	100
Stains, interior	250
Swimming pool coatings – repair	340
Swimming pool coatings – other	340
Traffic Coatings	100
Waterproofing sealers	100
Waterproofing concrete/masonry sealers	100
Wood preservatives	350
Low solids coatings	120

- C. EQc2, Low-Emitting Materials, Paints and Coatings: For field applications that are inside the weatherproofing system, 75% percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Provide cost or volume of product used.
- D. EQc2, Low-Emitting Materials, Adhesives and Sealants: For field applications that are inside the weatherproofing system, use adhesives and sealants that comply with the limits for VOC content when calculated according to South Coast Air Quality Management District (SCAQMD) Rule #1168, requirements in effect on October 6, 2016:

Architectural Applications:	Allowable VOC Content (g/L):
Indoor carpet adhesives	50
Carpet pad adhesives	50
Outdoor carpet adhesives	150
Wood flooring adhesives	100
Rubber floor adhesives	60
Subfloor adhesives	50
Ceramic tile adhesives	65
VCT and asphalt tile adhesives	50
Dry wall and panel adhesives	50
Cove base adhesives	50
Multipurpose construction adhesives	70
Structural glazing adhesives	100
Single ply roof membrane adhesives	250
Specialty Applications:	
PVC welding	510
CPVC welding	490
ABS welding	325
Plastic cement welding	250
Adhesive primer for plastic	550
Computer diskette manufacturing	350
Contact adhesive	80
Special purpose contact adhesive	250
Tire retread	100
Adhesive primer for traffic marking tape	150
Structural wood member adhesive	140
Sheet applied rubber lining operations specialty	850
Top and Trim adhesive	250
Substrate Specific Applications:	
Metal to metal substrate specific adhesives	30
Plastic foam substrate specific adhesives	50
Porous material (except wood) substrate specific adhesives	50
Wood substrate specific adhesives	30
Fiberglass substrate specific adhesives	80
Sealants:	
Architectural sealant	250
Marine deck sealant	760
Nonmember roof sealant	300
Roadway sealant	250
Single-ply roof membrane sealant	450
Other sealant	420
Sealant Primers:	
Architectural non-porous sealant primer	250
Architectural porous sealant primer	775
Modified bituminous sealant primer	500
Marine deck sealant primer	760

Other sealant primer	750
Other	
Other adhesives, adhesive bonding primers, adhesive primers or any other primers	250

Exception: The provisions of SCAQMD Rule 1168 do not apply to adhesives and sealants subject to state or federal consumer product VOC regulations.

- E. EQc2, Low-Emitting Materials, Adhesives and Sealants: For field applications that are inside the weatherproofing system, 75% percent of adhesives and sealants shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Provide **cost or volume** of product used on project.
- F. EQc2, Low-Emitting Materials, Flooring: 90% Flooring shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Provide **cost or surface area** of product used on project.
- G. EQc2, Low-Emitting Materials, Composite Wood: 75% of Composite wood, agrifiber products, and adhesives shall be made using ultra-low-emitting formaldehyde (ULEF) resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde. Provide **cost or surface area** of product used on project.
- H. EQc2, Low-Emitting Materials, Ceilings, Walls, Thermal, and Acoustic Insulation: Ceilings, walls, and thermal insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Provide **cost or surface area** of product used on project.
- I. Additional Low-Emitting Requirements:
 - 1. If the applicable regulation requires subtraction of exempt compounds, any content of intentionally added exempt compounds larger than 1% weight by mass (total exempt compounds) must be disclosed.
 - 2. If a product cannot reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, part 1; ASTM D6886-03; or ISO 11890-2.
 - 3. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealants.
- J. INDOOR WATER USE REDUCTION
 - 1. WEp2, Indoor Water Use Reduction, Appliances: Provide ENERGY STAR rated appliances.

2. WEp2/WEc2, Indoor Water Use Reduction, Plumbing Fixtures: Do not exceed water flow requirements indicated in Division 22 - PLUMBING.

K. EXECUTION

L. NONSMOKING BUILDING

1. EQp2, Environmental Tobacco Smoke Control: Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor-air intakes.
 - a. Refer to Section 01 81 13.01, "Indoor Air Quality Management."

M. CONSTRUCTION WASTE MANAGEMENT

1. MRp2 MRc5, Construction and Demolition Waste Management: Comply with Section 01 74 19 "Construction Waste Management and Disposal."

N. CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT

1. EQc3/EQc4, Construction Indoor Air Quality Management Plan: Comply with Section 01 81 13.01, "Indoor Air Quality Management."

END OF SECTION 018113

SECTION 018113.01 SUSTAINABILITY REQUIREMENTS - INDOOR AIR QUALITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements governing specifications for achieving indoor air quality (IAQ) objectives for the project.
 - 1. General: Interior construction assemblies, systems, materials, products and finishes, including but not limited to: insulation, partitions, partition coverings, flooring, floor coverings, wall coverings, ceiling finishes, adhesives, sealants, glazing, paints, casework and similar materials shall be manufactured, handled, and installed in such a manner to reduce health and comfort (including odor) effects on building occupants.
 - 2. The requirements of this Section relate to both site-applied and shop fabricated materials and products.

1.3 MEETING REQUIREMENTS

- A. General: Include Owner, Contractor, Architect and relevant subcontractors in IAQ meetings.
- B. Preconstruction Conference: Include IAQ in the agenda of the Preconstruction Conference at Project site prior to start of construction. Review IAQ requirements for interior assemblies, materials, products and finishes.
- C. Project Meetings: Include an update on the status of IAQ requirements at each regularly scheduled meeting as needed.

1.4 SUBMITTALS

- A. General: Coordinate IAQ submittals with other submittal requirements specified in the Technical Specification Sections, including material descriptions, product characteristics, and finishes; include IAQ data on furnished specialties and accessories.
- B. IAQ Product Data, General: For each type of material and product listed below that is used interior to the exterior waterproofing membrane, provide the following IAQ Product Data:
 - 1. VOC Content of Paints and Coatings: Product data indicating Volatile Organic Compound (VOC) content in grams per Liter (g/L). Options:
 - a. Manufacturer's Technical Data Sheet, or
 - b. Copy of product label.
 - 2. VOC Content for Adhesives and Sealants: Product data indicating Volatile Organic Compound (VOC) content in grams per Liter (g/L). Options:
 - a. Manufacturer's Technical Data Sheet, or
 - b. Copy of product label.

3. Formaldehyde Content:
 - a. Composite Wood and Agrifiber Products: Product data indicating No Added Formaldehyde (NAF) resin system for composite wood and agrifiber products from options listed below.
 - b. Insulation: Data for each batt, blanket and wet-spray insulation product indicating binder is not formaldehyde based. Data for spray-in-place insulation showing product is not formed by reacting an amine chemical group with formaldehyde.
 4. Product Data for Carpet Systems:
 - a. For carpet and carpet cushion, documentation indicating compliance with testing requirements of CRI's (Carpet and Rug Institute) "Green Label Plus" program. If alternative testing by CDPH (California Department of Public Health) Standard Method V1.2 is used, provide documentation as specified in Section C below.
 - b. For installation adhesive, documentation of VOC content in g/L.
 - c. NSF/ANSI 140 Sustainability Assessment for Carpet: Documentation indicating certified conformance level for broadloom and carpet tile products.
 5. Product Data for Resilient and Tile Flooring and Flooring Adhesives: Documentation indicating compliance with testing requirements of Resilient Floor Covering Institute (RFCI) FloorScore™ program. If alternative testing by CDPH Standard Method v1.2 is used, provide documentation as specified in Section C below.
 6. Product data for Ceilings, Walls and Thermal and Acoustic Insulation:
 - a. Insulation: Data for each batt, blanket and wet-spray insulation product (excluding insulation for HVAC ducts and plumbing piping), documentation indicating compliance with testing by CDPH (California Department of Public Health) Standard Method v1.2, as specified in Section C below.
 - b. Ceiling systems (ceiling panels, tile, surface ceiling structures, suspended systems, glazed skylights): Data for each wall system product, documentation indicating compliance with testing by CDPH (California Department of Public Health) Standard Method v1.2, as specified in Section C below.
 - c. Wall Systems (wall treatments, interior and exterior doors, gypsum/plaster wall structures, partition walls, trim, wall frames, interior and exterior windows, and window treatments): Data for each wall system product, documentation indicating compliance with testing by CDPH (California Department of Public Health) Standard Method v1.2, as specified in Section C below.
 7. Cleaning Products: Provide data for cleaning products used during regular construction cleaning and for final cleaning indicating compliance with standards and programs promoting use of safer ingredients such as U.S. EPA Design for the Environment (DfE) and Green Seal standards GS-37, GS-40 and GS-53.
- C. IAQ Emission Test Data and Certifications: The following documentation and certifications are acceptable for each interior product and finish that are required in the Technical Specification Sections to be tested for VOC emissions in accordance with CDPH Standard Method v1.2:
1. IAQ Test Data, General: Test report produced by an ISO/IEC 17025 accredited laboratory showing emission factors of emitted VOCs. Test shall have been conducted within three (3) years of the start date of Notice to Proceed for or commencement of construction of the project.
 2. Manufacturer's Self Declarations: Manufacturer's declaration of compliance with CDPH Standard Method v1.2 based on laboratory testing as described above.

3. Third Party Certifications: In lieu of declaration of compliance by the manufacturer, certification of compliance with CDPH Standard Method v1.2 made by a third party, ISO/IEC 17065 accredited certification body.
- D. Wood and Agrifiber Product Certifications: For each nonstructural composite wood and agrifiber product required to be IAQ compliant in the Technical Sections, the following documentation is acceptable:
1. California: Certification or copy of product label indicating that wood and agrifiber product is classified as No Added Formaldehyde (NAF) and is compliant with the California Air Resources Board (CARB) Airborne Toxic Control Measure (ATCM) for Composite Wood (17 CCR 93120 et seq.).
 2. Outside of California, Manufacturer's Self Declarations: Manufacturer's declaration or product data sheet indicating that product is produced using NAF resin binder
- E. Building Product Transparency for Material Ingredients: The following documentation and certifications are acceptable:
1. Health Product Declaration (HPD): Manufacturer's publicly available Health Product Declaration (HPD) with full disclosure of ingredients and known hazards that is in compliance with the Health Product Declaration Standard 1.0, 2012, and is verified by an ISO/IEC 17065 accredited certification body.
 2. Chemical Inventory: Manufacturer's publicly available chemical inventory of product ingredients to at least 0.1 percent (1,000 ppm) with all ingredients identified by name and Chemical Abstract Registration Number (CASRN). Name and CASRN of substance defined as trade secret or intellectual property may be withheld, but inventory shall disclose role, amount, and hazard benchmark rating of substance, as defined in GreenScreen v1.2.
 3. Environmental Product Declaration (EPD): Manufacturer's product life cycle assessment documenting environmental impact of the product throughout its life cycle (i.e., from cradle to cradle) that is verified by an ISO/IEC 17065 accredited certification body.
- F. Moisture-Protection Plan: Contractor's plan describing procedures and controls for protecting materials and construction from water absorption and damage.
1. Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.
 2. Describe procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
 3. Describe sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and concrete grinding. Describe plans for managing water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.

1.5 SUBSTITUTIONS

- A. Substitution requests for product types specified or indicated in the Contract Documents are also governed by this Section and shall meet the minimum requirements specified herein. Substitution requests shall require documentation indicating compliance with the relevant requirements specified in this Section.
1. For products where compliance with specified IAQ requirements may not be possible, alternative IAQ solutions shall be developed by the Contractor and approved by Architect before being implemented.

1.6 QUALITY ASSURANCE

- A. Coordination: Coordinate IAQ management activities with additional environmental requirements specified in Division 01 through Division 49 Specification Sections
- B. Laboratory Test Requirements: Laboratory tests shall be performed by ISO/IEC 17025 accredited laboratories.
- C. Third Party Certification and Verification Requirements: Certification and verification of environmental product claims shall be performed by ISO/IEC 17065 accredited certification bodies.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Products used on the project shall be as new, shall not have been exposed to water, and shall not have visible mold or mildew growth.
- B. Moisture Protection: Protect interior materials from water intrusion or penetration.
 - 1. Porous or fibrous materials with visible mold or mildew growth shall not be installed and shall be removed from the site and disposed of appropriately.
 - 2. Notify Owner and Architect immediately that mold or mildew is detected. Once discovered, no onsite or offsite treatment of mold and mildew with cleaning agents or other chemicals, including ozone, is permitted.
 - 3. Keep porous and organic materials from coming into prolonged contact with any concrete surface.
 - 4. Remove standing water from decks; keep deck openings covered to prevent water intrusion into the project.

1.8 PROJECT CONDITIONS

- A. Provide and maintain controlled interior environmental conditions in accordance with mechanical engineer's requirements before beginning installation of interior finish materials.
- B. Smoking shall not be permitted in indoor and outdoor Project site locations.
- C. Construction Ventilation and Preconditioning, General:
 - 1. Comply with ventilation and testing requirements specified in Mechanical Technical Specification Sections, or as directed by Mechanical Engineer.
 - 2. Provide temporary ventilation for one hour prior to, during, and for 24 hours after completion of installation of interior products that emit vapors from organic solvents.

1.9 CLEANING AND PROTECTION, ENVIRONMENTAL ISSUES

- A. Cleaning Agents, General: Use cleaning products and agents recommended by or acceptable to manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that may damage finished surfaces. Preferentially use cleaning agents with safer ingredients as defined by governmental or non-governmental programs.

- B. Final Cleaning, Environmental Issues: Use nontoxic cleaning and maintenance products as described in this Section.
 - 1. Comply with IAQ Management Plan During Construction, Housekeeping, as specified in this Section.
 - 2. Clean interior and exterior surfaces exposed to view; remove temporary labels, stains, and foreign substances; polish transparent and glossy surfaces.
 - 3. Clean equipment and fixtures to sanitary condition.
 - 4. Remove and properly dispose of recyclable materials using a specified construction waste management program.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: These requirements apply to interior building materials, products, and finishes located within the weatherproofing system, unless otherwise noted.
- B. Volatile Organic Compound (VOC) Emissions: Emissions for interior materials, products and finishes shall meet the California Department of Public Health (CDPH) Standard Method v1.2, 2017 requirements for modeled indoor air concentrations based on the private office scenario (Section 4.3.5).
- C. Volatile Organic Compound (VOC) Content, Adhesives and Sealants: Site applied adhesives and sealants shall comply with South Coast Air Quality Management District (SCAQMD) Rule 1168, Adhesive and Sealant Applications, amended January 5 2005.
- D. Volatile Organic Compound (VOC) Content, Paints and Coatings: Site applied paints and coatings shall comply with one or both of the following:
 - 1. South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, amended September 6, 2013.
 - 2. California Air Resources Board (CARB) Suggested Control Measure (SCM) for Architectural Coatings, 2007.
- E. Composite Wood and Agrifiber Products for interior non-structural use:
 - 1. California: Composite wood products shall comply as No Added Formaldehyde (NAF) under California Air Resources Board (CARB) Airborne Toxic Control Measure (ATCM) for Composite Wood (17 CCR 93120 et seq.). Note that product labels showing compliance are required for most composite wood and agrifiber products sold and used within the State of California but are optional in other jurisdictions. Labels should indicate products are NAF compliant.
 - 2. California (but not included under CARB ATCM): Products shall be produced using NAF resin binder.
 - 3. Outside of California: Products shall be produced using NAF resin binder.
- F. US Green Building Council LEED v4 Requirements: If the project is required to comply with the USGBC LEED® for Homes v4 or LEED for Homes, Mid-Rise Multi-Family v4 Green Building Rating systems, comply with requirements of appropriate prerequisites and credits as indicated and specified for use on this Project.

- G. International Living Futures Institute (ILFI) Living Building Challenge (LBC) v3.0 Requirements: Comply with requirements of Petals and Imperatives performance categories as indicated and specified for use on this Project.

2.2 PRODUCTS, GENERAL

- A. General: These requirements are in addition to the performance requirements indicated above.

B. Adhesives and Sealants:

1. No adhesive and sealant shall contain formaldehyde or a formaldehyde precursor as an ingredient.
2. Silicone rubber caulks and sealants containing acetic acid as an ingredient only are permitted to be used in limited quantity in kitchen, bath and utility areas where it is necessary to obtain a water-tight seal.
3. SCAQMD Rule 1168: For field applications that are inside the weatherproofing system, adhesives and sealants shall comply with the following VOC content limits when calculated as required in Rule 1168 as amended January 2005, or most current version:
 - a. Wood Glues: 30 g/L.
 - b. Metal-to-Metal Adhesives: 30 g/L.
 - c. Adhesives for Porous Materials (Except Wood): 50 g/L.
 - d. Subfloor Adhesives: 50 g/L.
 - e. Plastic Foam Adhesives: 50 g/L.
 - f. Carpet Adhesives: 50 g/L.
 - g. Carpet Pad Adhesives: 50 g/L.
 - h. VCT and Asphalt Tile Adhesives: 50 g/L.
 - i. Cove Base Adhesives: 50 g/L.
 - j. Gypsum Board and Panel Adhesives: 50 g/L.
 - k. Rubber Floor Adhesives: 60 g/L.
 - l. Ceramic Tile Adhesives: 65 g/L.
 - m. Multipurpose Construction Adhesives: 70 g/L.
 - n. Fiberglass Adhesives: 80 g/L.
 - o. Contact Adhesive: 80 g/L.
 - p. Structural Glazing Adhesives: 100 g/L.
 - q. Wood Flooring Adhesive: 100 g/L.
 - r. Structural Wood Member Adhesive: 140 g/L.
 - s. Special-Purpose Contact Adhesive: 250 g/L.
 - t. Top and Trim Adhesive: 250 g/L.
 - u. Adhesive Primer for Plastic: 550 g/L.
 - v. Aerosol Adhesive, General-Purpose Mist Spray: 65 percent by weight.
 - w. Aerosol Adhesive, General-Purpose Web Spray: 55 percent by weight.
 - x. Special-Purpose Aerosol Adhesive (All Types): 70 percent by weight.
 - y. Other Adhesives: 250 g/L.
 - z. Architectural Sealants: 250 g/L.
 - aa. Other Sealants: 420 g/L.
 - bb. Sealant Primers for Nonporous Substrates: 250 g/L.
 - cc. Sealant Primers for Porous Substrates: 775 g/L.
 - dd. Other Sealant Primers: 750 g/L.

- C. Paints and Coatings:

1. No paint and coating shall contain formaldehyde as an ingredient or contain chemicals that react in the product to produce formaldehyde.
 2. All finish coatings shall be formulated with water-based technologies (i.e., water-based polyurethane, acrylic/polyurethane, acrylic, UV, or polyester) with the exceptions that solvent-based wipe stains may be used as wood finishes and epoxy coatings may be used in small areas for specialty applications.
 3. Paints and coatings applied to interior doors, casework and other components produced offsite shall comply with the requirements given below.
 4. SCAQMD Rule 1113: For field applications that are inside the weatherproofing system, paints and coatings shall comply with the following VOC content limits when calculated as required in Rule 1113 as amended September 2013:
 - a. Flat Paints and Coatings: 50 g/L.
 - b. Non-flat Paints and Coatings: 150 g/L.
 - c. Primers, Sealers, and Undercoaters: 200 g/L.
 - d. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 - e. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
 - f. Pretreatment Wash Primers: 420 g/L.
 - g. Clear Wood Finishes, Varnishes: 350 g/L.
 - h. Clear Wood Finishes, Lacquers: 550 g/L.
 - i. Floor Coatings: 100 g/L.
 - j. Shellacs, Clear: 730 g/L.
 - k. Shellacs, Pigmented: 550 g/L.
 - l. Stains: 250 g/L.
 5. CARB SCM, Table 1: For field applications that are inside the weatherproofing system, paints and coatings shall comply with the following VOC content limits when calculated as required by the SCM:
 - a. Flat Coatings: 50 g/L.
 - b. Non-flat Coatings: 100 g/L.
 - c. Non-flat – High Gloss Coatings: 150 g/L.
 - d. Wood Coatings: 275 g/L.
 - e. Floor Coatings: 100 g/L.
 - f. Primers, Sealers and Undercoaters: 100 g/L.
 - g. Stains: 250 g/L.
 - h. Concrete/Masonry Sealers: 100 g/L.
- D. Thermal and Acoustic Insulation, General:
1. Insulation material, including mineral/rock wool insulation, shall not contain formaldehyde-based binder as an ingredient.
 2. Insulation material shall be fire retardant free unless required by local building code.
 3. Insulation shall comply with VOC emissions testing as indicated in this Section.
- E. Carpet and Carpet Cushion:
1. Comply with Carpet and Rug Institute (CRI) “Green Label Plus” program testing requirements for carpet and the “Green Label” program testing requirements for carpet cushion.
 2. ANSI/NSF 140: For carpet, meet Achievement Level of Gold, 52 to 70 points, based on specific Sustainable Attribute Performance for all product stages according to ANSI/NSF 140.

- F. Resilient and Tile Flooring: Comply with Resilient Floor Covering Institute (RFCI) “FloorScore®” program testing requirements for flooring and flooring adhesives.
- G. Wood, Composite Wood, Agrifiber Products and Components: Manufactured, prefinished, and engineered wood products shall comply with indicated VOC requirements:
1. Moldings and Trim: Interior moldings and trim materials shall be solid wood or finger-jointed wood. No MDF or other composite wood products shall be used for moldings and trim.
 2. Shelving and Panels: Built-in shelving, including closet shelving and organizers, and wood panels applied to walls, columns and other structures, shall consist of hardwood plywood (HWPW) with no-added formaldehyde (NAF) veneer core.
 3. Stair Components: Stair components (handrails, balusters, posts, treads, risers and stringers) shall be solid wood. Alternately treads and risers may consist of hardwood plywood (HWPW) with NAF veneer core.
 4. Built-In Casework, General:
 - a. Casework cases shall employ either solid wood or all plywood construction (APC) including end panels, ceilings, floors, backs, shelves and interior support beams.
 - b. Casework drawers shall consist of solid wood drawer sides and HWPW NAF drawer bottoms.
 - c. Casework interiors shall be finished wood veneer, high-pressure laminate or equivalent.
 - d. Finish coatings shall be water-based polyurethane, acrylic/polyurethane, acrylic, UV, or polyester. Finish coatings shall not contain or produce formaldehyde (i.e., acid cured or catalyzed finishes are prohibited).
 5. Interior Doors, General: Preferred Option, interior doors shall be solid wood construction.
- H. Countertops, General:
1. Kitchen, bath and utility countertops shall be concrete, stone, recycled paper composite, recycled plastic, terrazzo or other products that meet the specified VOC requirements of this Section.
 2. Countertops shall be installed over substrates that are in compliance with the VOC requirements of this Section.
- I. Gypsum Board Walls and Ceilings, General:
1. Attachment Method: Paper-faced and paperless gypsum wall board (GWB) shall be applied with conventional mechanical fasteners. Solvent-containing adhesives shall not be used for application of gypsum board.
 2. Gypsum board shall comply with VOC emissions testing as indicated in this Section.
- J. Living Building Challenge (LBC) Red List Materials: Subject to specific exceptions as defined by the Living Building Challenge v3.0, products shall not contain Red List Materials as listed in the Materials Petal, Responsible Industry Imperative 10.
- K. Environmentally Preferable Products, Transparency: Provide at least 20 products on the project having documentation of one or more of the following:
1. Health Product Declaration Collaborative: Completed Health Product Declaration (HPD) Standard, latest version.
 2. Cradle to Cradle Products Innovation Institute: Cradle to Cradle Certified V3.0; Bronze Level minimum.
 3. International Living Future Institute: Living Building Challenge; Declare label.

4. Environmental Product Declarations (EPD): Manufacturer's Environmental Product Declaration.

PART 3 - EXECUTION

3.1 MOISTURE AND MOLD CONTROL

- A. General: Protect materials as follows:
 1. Do not load or install drywall, other porous materials and components, and items with high organic content into partially enclosed building.
 2. Keep interior spaces clean and protected from water damage; periodically collect and remove waste containing cellulose or other organic matter.
 3. Comply with manufacturer's written instructions for storage of products with respect to temperature, relative humidity, and water exposure limits.
 4. Document visible signs of mold and mildew that may appear during construction. Report findings in writing to Owner and Architect.

3.2 CONSTRUCTION IAQ MANAGEMENT DURING CONSTRUCTION

- A. Construction IAQ Management Plan During Construction: General IAQ Plan requirements during construction include:
 1. Attached Garage Pollutant Protection.
 2. HVAC protection.
 3. Source control.
 4. Pathway interruption.
 5. Housekeeping.
 6. Scheduling.
- B. Attached Garage Pollutant Protection, General:
 1. Enclose garage with air barrier to completely separate the habitable area of the home from the garage. The air barrier material shall be installed from the floor slab to the structure above. Gypsum board assemblies shall be sealed at the top and bottom with sealants that comply with the IAQ requirements of this Section.
 2. Install weather stripping or gasket and threshold on all passageways between living space and attached garage.
 3. Provide an exhaust fan with automatic timer controls linked to an occupant sensor, light switch, garage door opening mechanism, a carbon monoxide sensor that turns on the fan when the garage CO level reaches 35 ppm, or equivalent. Fan shall be vented directly outdoors, have a minimum capacity of 75 cfm and be capable of ventilating garage space at three air changes per hour for a typical two car garage. Fan shall operate for at least one hour after event triggering fan operation.
- C. HVAC Protection:
 1. Use of permanent heating, cooling, and ventilating systems during construction period is not permitted.
 2. Comply with SCMACNA requirements for protection of air handling and distribution equipment and air supply and return ducting during construction.
 3. Adequately cover and protect exposed air inlets and outlets, openings, grilles, ducts, plenums, as required to prevent water, moisture, and other contaminant intrusion.
 4. Apply protection immediately after installation of equipment and ducting.

5. Ducting runs that require more than a single day to install shall be protected at the end of each day's work.
 6. Replace air filtration media immediately prior to occupancy.
- D. Pathway Interruption:
1. All openings within the designated work area shall be sealed while wet work is being performed to prevent contamination in adjacent areas.
 2. Temporary ventilation shall be exhausted to the outside of the building.
- E. Housekeeping:
1. Provide temporary ventilation during construction to minimize accumulation of dust fumes, vapors, or gases in the building.
 2. Continuously ventilate during and after installation of materials that emit VOCs until emissions dissipate:
 - a. Period after installation shall be sufficient to dissipate odors and elevated levels of VOCs. Provide temporary ventilation for one hour prior to, during, and for 24 hours after completion of installation of VOC emitting products.
 - b. Ventilate areas directly to outside, do not ventilate to other enclosed spaces.
 - c. Ventilate via open windows and temporary fans that provide no less than three air changes per hour.
 3. Use dust collection attachments on saws, sanders, and other power tools that generate dust particles.
 4. Suppress dust with wetting agents or sweeping compounds.
 5. Clean-up dust using a wet rag or damp mop.
 6. Increase the cleaning frequency when dust build-up is noted.
 7. Remove spills or excess applications of solvent-containing products as soon as possible.
 8. Remove accumulated water and keep work areas as dry as possible.
 9. Store and keep volatile liquid containers closed when the container is inside of the building and not in use.
 10. HEPA vacuuming and duct cleaning.
 - a. Vacuum carpeted and soft surfaces with a high efficiency particulate arrestor (HEPA) vacuum.
 - b. If ducts contain dust and dirt, clean them using a HEPA vacuum immediately before substantial completion and prior to using the ducts to circulate air.
 - c. Oil film on sheet metal should be removed before shipment to site. Ducts shall be inspected to confirm that no oil film is present. Remove oil that may be remaining.
 11. Use nontoxic cleaning materials and procedures.
- F. Scheduling:
1. General: Comply with manufacturer's instructions for appropriate drying times.
 2. Protect installed absorbent materials with recycled or recyclable materials.
 3. Where odorous and/or high VOC-emitting products are applied on site, apply them before installation of porous and fibrous materials. Where this is not possible, protect porous materials with polyethylene vapor retarders.
 4. Insure that wet applied interior finish materials, such as paints, adhesives, sealants, coatings, finishes, and spray-applied materials, such as structural fireproofing, are properly and fully cured before installing other finish materials over them.
 5. Install carpets and furnishings after all other interior finish materials have been applied and fully cured.

6. Provide adequate ventilation of packaged dry products prior to installation. If space is available, remove from packaging and ventilate in a secure, dry, well-ventilated space free from strong contaminant sources and residues.
7. Complete interior finish material installation no less than 14 days prior to Substantial Completion to allow for building flush-out.

3.3 CONSTRUCTION IAQ MANAGEMENT PLAN BEFORE OCCUPANCY

- A. Construction IAQ Testing Plan Before Occupancy: Comply with the following requirements:
 1. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out.
 2. Flush for at least 48 hours total; the hours may be non-consecutive if necessary.
 3. Keep operable windows and interior doors open and run HVAC system fan (or large portable commercial fan) continuously, or flush home with HVAC system fans and exhaust fans (or large portable commercial fans) operating continuously at the highest flow rate.
 4. Use additional temporary large portable commercial fans to circulate air within the house.
 5. Replace air filtration media immediately prior to occupancy.
 6. If required by Owner; perform IAQ testing following LEED v4 for Interior Design and Construction, Option 2 air testing procedures, or alternate procedure developed by qualified IAQ Engineer.

END OF SECTION 018113.01

APPENDIX A – REFERENCES AND RESOURCES

3.4 REFERENCES AND RESOURCES

- A. Airborne Toxic Control Measure (ATCM) 93120-93120.12, Title 17, California Code of Regulations.
- B. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
 - 1. ASHRAE Standard 52.2: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size (ANSI Approved) for defining Minimum Efficiency Reporting Value (MERV).
 - a. Minimum efficiency Reporting Value (MERV) of 8 for filtration media.
 - b. Minimum efficiency Reporting Value (MERV) of 13 for filtration media.
 - 2. ASHRAE Standard 62.1: Ventilation for Acceptable Indoor Air Quality (ANSI Approved).
 - a. Sections 4 through 7.
 - b. Definition of minimum outdoor air rate.
 - 3. ASHRAE Standard 62.2: Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings.
- C. ASTM International (ASTM)
 - 1. ASTM D1356: Standard Terminology Relating to Sampling and Analysis of Atmospheres.
 - 2. ASTM D5116: Guide for Small Scale Environmental Chamber determination of Organic Emissions from Indoor Materials/Products.
 - 3. ASTM D5197: Standard Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology).
 - 4. ASTM D6329: Standard Guide for Developing Methodology for Evaluating the Ability of Indoor Materials to Support Microbial Growth Using Static Environmental Chambers.
 - 5. ASTM D6345: Standard Guide for Selection of Methods for Active, Integrative Sampling of Volatile Organic Compounds in Air.
 - 6. ASTM D6670: Standard Practice for Full-Scale Chamber Determination of Volatile Organic Emissions from Indoor Materials/Products.
 - 7. ASTM D6886: Standard Test Method for Determination of the Individual Volatile Organic Compounds (VOCs) in Air-Dry Coatings by Gas Chromatography
 - 8. ASTM D7339: Standard Test Method for Determination of Volatile Organic Compounds Emitted from Carpet using a Specific Sorbent Tube and Thermal Desorption / Gas Chromatography.
 - 9. ASTM E2114: Standard Terminology for Sustainability Relative to the Performance of Buildings.
- D. Cal/EPA, California Air Resources Board (CARB)
 - 1. Airborne Toxic Control Measure (ATCM) for formaldehyde in composite wood products: <http://www.arb.ca.gov/toxics/compwood/compwood.htm>
 - 2. Architectural and Industrial Coatings Program (AIM) – 2007 Suggested Control Measure (SCM), 2008: <http://www.arb.ca.gov/coatings/arch/docs.htm>
 - 3. Toxic Air Contaminants (TACs). Current version of list is accessible at <http://www.arb.ca.gov/toxics/id/taclist.htm>

- E. Cal/EPA, Office of Environmental Health Hazard Assessment (OEHHA)
 1. Non-cancer health effects. Acute, 8-hour and Chronic Reference Exposure Levels (RELs). Current version of this list is accessible at <http://oehha.ca.gov/air/allrels.html>
 2. Safe Drinking Water and Toxic Enforcement Act or 1986 (Proposition 65). Current version of list is accessible at http://www.oehha.ca.gov/prop65/prop65_list/newlist.html
- F. CALGreen: 2013 California Green Building Standards Code, California Code of Regulations, Title 24, Part 11. Current version of code is accessible at <https://law.resource.org/pub/us/code/bsc.ca.gov/>
- G. California Department of Public Health (CDPH), CDPH/EHLB/Standard Method V1.2: Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, Version 1.1 (Emission Testing Method for California Specification 01350); accessible at <http://www.cal-iaq.org/separator/voc/standard-method>
- H. Carpet and Rug Institute (CRI): Green Label Plus Certification for carpet and carpet cushion; accessible at <http://www.carpet-rug.org/>
- I. Cradle to Cradle Products Innovation Institute: Cradle to Cradle (C2C) Certified Products Program; accessible at http://www.c2ccertified.org/product_certification/c2ccertified_product_standard
- J. Green Seal; accessible at <http://www.greenseal.org/FindGreenSealProductsAndServices.aspx>
 1. Green Seal Standard GS-11, Paints and Coatings.
 2. Green Seal Standard GS-36, Adhesives for Commercial Use.
 3. Green Seal Standard GS-42, Commercial and Institutional Cleaning Services.
 4. Green Seal Standard GS-49, Residential Cleaning Services.
- K. GreenScreen for Safer Chemicals: Method for chemical hazard assessment; accessible at <http://www.greenscreenchemicals.org/>
- L. Health Product Declaration Collaborative; Health Product Declaration (HPD) Standard Version 1.0; accessible at <http://hpdcollaborative.org>
- M. International Green Construction Code (IgCC); accessible at <http://www.iccsafe.org/CS/IGCC/Pages/default.aspx>
- N. International Living Futures Institute (ILFI); accessible at <http://living-future.org/lbc>.
 1. Living Building Challenge (LBC) Standard 3.0, 2014.
 2. Material Petals Handbook, 2013
 3. Declare, The Ingredients Label for Building Products; accessible at www.declareproducts.com.
- O. International Organization for Standardization (ISO)
 1. ISO 14021:2001. Environmental labels and declarations. Self-declared environmental claims (Type II environmental labeling).
 2. ISO 16000-9:2006. Indoor Air - Part 9: Determination of the Emission of Volatile Organic Compounds from Building Products and Furnishing - Emission Test Chamber Method.
 3. ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories.

4. ISO/IEC 17065: 2012 Conformity Assessment – Requirements for Bodies Certifying Products, Processes and Services
 5. ISO/IEC Guide 65:1996 General Requirements for Bodies Operating Product Certification Systems.
- P. North East Ozone Transport Commission (OTC)
1. Model Rule 2009-12; Architectural & Industrial Maintenance (AIM) Coatings.
 2. Model Rule for Adhesives and Sealants.
- Q. Resilient Floor Covering Institute (RFCI): FloorScore emissions criteria and testing method for hard surface flooring and flooring adhesives; accessible at SCS Global Services website <http://www.scsglobalservices.com/floorscore>
- R. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): IAQ Guidelines for Occupied Buildings Under Construction, 2nd Edition 2007, ANSI/ SMACNA 008-2008 (Chapter 3).
- S. South Coast Air Quality Management District (SCAQMD)
1. SCAQMD Rule 1113, Architectural Coatings: VOC limits for AIM paints and coatings; accessible at: <http://www.aqmd.gov/rules/reg/reg11/r1113.pdf>
 2. SCAQMD Rule 1168, Adhesive and Sealant Applications: VOC limits for primers, adhesives, sealants, and sealant and other primers; accessible at: <http://www.arb.ca.gov/drdb/sc/curhtml/r1168.pdf>
- T. US Environmental Protection Agency (EPA)
1. Indoor airPLUS Construction Specifications, Version 1 (Rev. 02): <http://www.epa.gov/indoorairplus>
 2. 40 CFR 59, Subpart D, Method 24, Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings; accessible at <http://www.epa.gov/ttnemc01/promgate/m-24.pdf>
 3. Building Radon Out (EPA 402-K-01-002): Building Radon Out: A Step-by-Step Guide On How to Build Radon-Resistant Homes, 2001; accessible at <http://www.epa.gov/radon/pdfs/buildradonout.pdf>
 4. Environmentally Preferable Purchasing Guidelines for Cleaning Agents; accessible at <http://www.epa.gov/opptintr/epp/pubs/cleaning.htm>
 5. Map of Radon Zones; accessible at <http://www.epa.gov/radon/zonemap.html>
 6. Toxic Substances Control Act (TSCA), Section 5(b)(4): Chemicals of Concern; accessible at <http://www.epa.gov/oppt/existingchemicals/index.html>
- U. US Green Building Council (USGBC)
1. Leadership in Energy and Environmental Design (LEED), LEED for Homes Design and Construction, v4. Includes ‘Homes and Multifamily Lowrise’ and ‘Multifamily’; accessible at <http://www.usgbc.org/leed/v4>
 2. USGBC Buyer’s Guide to Green Countertops; accessible at: <http://greenhomeguide.com/know-how/article/buyers-guide-to-green-countertop-materials>

APPENDIX B – DEFINITIONS

3.5 DEFINITIONS

- A. Absorption: The process of one substance entering into the inner structure of another. (*U.S. EPA*).
- B. Absorptive Materials: Materials capable of absorption.
- C. Adsorption: The adhesion of a thin film of liquid or gases to the surface of a solid substance. (*U.S. EPA*).
- D. Air Change Rate: Ratio of volume of conditioned air brought into the emission test chamber or building space per unit time to the chamber or building space volume. (*CDPH IAQ Standard Method V1.2, 2017*).
- E. Allergen: A chemical or biological substance (e.g., pollen, animal dander, or house dust mite proteins) that induces an allergic state or reaction, characterized by hypersensitivity. A substance that induces allergic reaction. (*US EPA, 2012*).
- F. Annoyance: A general feeling of displeasure or adverse psychological reaction toward a source. Associated with disturbance, distress and frustration. (*US EPA, 2012*).
- G. ASHRAE: American Society of Heating, Refrigerating, and Air-Conditioning Engineers is an international group which is organized for the purpose of advancing the arts and sciences of heating, ventilation, air conditioning and refrigeration through research, standards writing, continuing education and publications. See www.ashrae.org. (*US EPA, 2012*).
- H. Asthma: A condition marked by recurrent attacks of difficult or labored breathing and wheezing resulting from spasmodic contraction and hypersecretion of the bronchi. It is caused by exposure to allergens such as drugs, foods, environmental pollutants, or intrinsic factors. (*US EPA, 2012*).
- I. ASTM International: American Society for Testing and Materials, a consensus-based standard setting organization. See www.astm.org. (*US EPA, 2012*).
- J. Breathing Zone: Area of a room in which occupants breathe as they stand, sit, or lie down. (*US EPA, 2012*).
- K. Building Flush Out: A process used to remove VOCs from a building by operating the building's HVAC system at 100 percent, tempered outside air for a specific period of time.
- L. Building-Related Illness (BRI): Diagnosable illness whose symptoms can be identified and whose cause can be directly attributed to airborne building pollutants (e.g., Legionnaire's disease, hypersensitivity pneumonitis). Also: A discrete, identifiable disease or illness that can be traced to a specific pollutant or source within a building. (Contrast with "Sick building syndrome"). (*US EPA, 2012*).
- M. Carcinogen: A substance that can cause or contribute to cancer. (*US EPA, 2012*).

- N. CDPH/EHLB/Standard Method V1.2: Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2. Emission testing method for California Specification 01350. Supersedes previous version “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers”. Prepared by Indoor Air Quality Section, Environmental Health Laboratory Branch, Division of Environmental and Occupational Disease Control, California Department of Public Health. January 2017.
- O. Concentration: Mass of VOC per unit air volume expressed at standardized conditions for temperature and pressure (i.e., 298° K, 101.3 kPa) (*CDPH IAQ Standard Method V1.2, 2017*).
- P. Contaminant: Any physical, chemical, biological, or radioactive substance that can adversely affect air, water or soil. (*US EPA, 2012*).
- Q. CREL – Noncancer chronic reference exposure level developed by Cal/EPA OEHHA. These are inhalation concentrations to which the general population, including sensitive individuals, may be exposed for long periods (10 years or more) without the likelihood of serious adverse systemic effects other than cancer. (*CDPH IAQ Standard Method V1.2, 2017*).
- R. Emission: Pollution discharge from a source. (*US EPA, 2012*).
- S. Emission Factor: Mass of VOC emitted from a specific unit area of product surface per unit time. Other unit measures such as product mass or length may be used as appropriate. (*CDPH IAQ Standard Method V1.2, 2017*).
- T. Emission Rate: Mass of VOC emitted by an entire product or test specimen per unit time. (*CDPH IAQ Standard Method V1.2, 2017*).
- U. Emission Test Chamber: Non-contaminating enclosure of defined volume with controlled environmental conditions for inlet air flow rate, temperature and humidity used for determination of VOC emissions from product test specimens. (*CDPH IAQ Standard Method V1.2, 2017*).
- V. EPA: United States Environmental Protection Agency.
- W. HEPA: High efficiency particulate arrestance (filters). (*US EPA, 2012*).
- X. Hypersensitivity: The immune system's exaggerated response to an allergen. (*US EPA, 2012*).
- Y. Hypersensitivity Diseases: Diseases characterized by allergic responses to animal antigens. The hypersensitivity diseases most clearly associated with indoor air quality are asthma, rhinitis, and hypersensitivity pneumonitis. Hypersensitivity pneumonitis is a rare but serious disease that involves progressive lung damage as long as there is exposure to the causative agent. (*US EPA, 2012*).
- Z. IAQ Management Plan: A set of flexible and specific steps for preventing and resolving IAQ problems. (*US EPA, 2012*).

- AA. Indoor Air Quality (IAQ): As defined in ANSIASHRAE Standard 62.2, acceptable indoor air quality is “air towards which a substantial majority of occupants express no dissatisfaction with respect to odor and sensory irritation and in which there are not likely to be contaminants at concentrations that are known to pose a health risk.”
- BB. Indoor Air Pollutant: Particles and dust, fibers, mists, bioaerosols, and gases or vapors. (*US EPA, 2012*).
- CC. Loading Factor: Ratio of the nominal exposed surface area of the product or the test specimen to the volume of the building space or the emission test chamber. (*CDPH IAQ Standard Method V1.2, 2017*).
- DD. Mutagen: Any substance that can cause a change in genetic material. (*US EPA, 2012*).
- EE. Mutagenic: Able to cause a permanent change in the structure of DNA. (*US EPA, 2012*).
- FF. Off-Gassing: The production of gases from the chemical deterioration of a substance over time, and the release of gases from materials into the air. (*US EPA, 2012*).
- GG. Organic Compounds: Chemicals that contain carbon. Volatile organic compounds vaporize at room temperature and pressure. They are found in many indoor sources, including many common household products and building materials. (*US EPA, 2012*).
- HH. Particulate Matter: A state of matter in which solid or liquid substances exist in the form of aggregated molecules or particles. Airborne particulate matter is typically in the size range of 0.01 to 100 micrometers. (*US EPA, 2012*).
- II. Preconditioning: A process of airing out building materials and furnishings to allow the VOCs to emit prior to installation in a building. The preconditioning of unwrapped materials and furnishings should be accomplished in a well ventilated space.
- JJ. Pressed Wood Products: A group of materials used in building and furniture construction that are made from wood veneers, particles, or fibers bonded together with an adhesive under heat and pressure. (*US EPA, 2012*).
- KK. Product Category: General group of similar products intended for a particular application and performance, such as vinyl composition tile (VCT), laminated wood flooring, broadloom carpet, sheet vinyl flooring, plywood, oriented strand board (OSB), interior paint, etc. (*CDPH IAQ Standard Method V1.2, 2017*).
- LL. Product Subcategory: Group of products within a product category having similar chemistry, construction, weight, formulation and manufacturing process and which may have a similar VOC emissions profile. (*CDPH IAQ Standard Method V1.2, 2017*).
- MM. Respirable Particles: Respirable particles are those that penetrate into and are deposited in the nonciliated portion of the lung. Particles greater than 10 micrometers aerodynamic diameter are not respirable. (*US EPA, 2012*).

- NN. Sick Building Syndrome (SBS): Term that refers to a set of symptoms that affect some number of building occupants during the time they spend in the building and diminish or go away during periods when they leave the building. SBS cannot be traced to specific pollutants or sources within the building. (Contrast with "Building related illness"). (*US EPA, 2012*).
- OO. Total Volatile Organic Compounds (TVOCs): Sum of the concentrations of all identified and unidentified VOCs between and including n-pentane through n-heptadecane (i.e., C5 – C17) as measured by the GC/MS TIC method and expressed as a toluene equivalent value. (*CDPH IAQ Standard Method V1.2, 2017*).
- PP. Toxic: Of, affected by, or caused by a toxin; to cause a poisonous reaction. (*US EPA, 2012*).
- QQ. Volatile: 1. Able to evaporate readily. 2. Able to go to gas phase from a liquid or solid phase. (*US EPA, 2012*).
- RR. Volatile Organic Compounds (VOCs): Compounds that vaporize (become a gas) at room temperature. Common sources which may emit VOCs into indoor air include housekeeping and maintenance products, and building and furnishing materials. In sufficient quantities, VOCs can cause eye, nose, and throat irritations, headaches, dizziness, visual disorders, memory impairment; some are known to cause cancer in animals; some are suspected of causing, or are known to cause, cancer in humans. At present, not much is known about what health effects occur at the levels of VOCs typically found in public and commercial buildings. (*US EPA, 2012*).
- SS. VOC Content: Volatile organic compound contained in the product.
- TT. VOC Emissions: Volatile organic compounds emitted by a product into the air.

SECTION 032000 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Steel reinforcement bars.
 2. Welded-wire reinforcement.

1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
1. Each type of steel reinforcement.
 2. Epoxy repair coating.
 3. Zinc repair material.
 4. Bar supports.
 5. Mechanical splice couplers.
 6. Structural thermal break insulated connection system.
- B. Sustainable Design Submittals:
1. [Type III Environmental Product Declaration \(EPD\)](#): For each product.
 2. [Sourcing of Raw Materials](#): Corporate sustainability report for each manufacturer.
 3. [Manufacturer Inventory](#): Provide manufacturer's ingredient inventory.
- C. Shop Drawings: Comply with ACI SP-066:
1. Include placing drawings that detail fabrication, bending, and placement.
 2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
 3. For structural thermal break insulated connection system, indicate general configuration, insulation dimensions, tension bars, compression pads, shear bars, and dimensions.
- D. Construction Joint Layout: Indicate proposed construction joints required to build the structure.
1. Location of construction joints is subject to approval of Architect.
- E. .

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1. Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M.
- B. Material Certificates: For each of the following, signed by manufacturers:
 1. Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."
 2. Dual-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."
- C. Material Test Reports: For the following, from a qualified testing agency:
 1. Steel Reinforcement:
 - a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.
 2. Mechanical splice couplers.
- D. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
 1. Store reinforcement to avoid contact with earth.
 2. Do not allow stainless steel reinforcement to come into contact with uncoated reinforcement.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
 1. Regional Materials: Manufacture steel within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.
- B. Reinforcing Bars: ASTM A615/A615M, [**Grade 60 (Grade 420)**], deformed.
- C. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.

- D. Headed-Steel Reinforcing Bars: ASTM A970/A970M.
- E. Galvanized Reinforcing Bars:
 - 1. Steel Bars: ASTM A615/A615M, Grade 60 (Grade 420), deformed bars.
 - 2. Zinc Coating: ASTM A767/A767M, Class I zinc coated after fabrication and bending.
- F. Steel Bar Mats: ASTM A184/A184M, fabricated from ASTM A615/A615M, Grade 60 (Grade 420), deformed bars, assembled with clips.
- G. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.
- H. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.
- I. Galvanized-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from galvanized-steel wire into flat sheets.

2.2 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/A615M, Grade 60 (Grade 420), plain-steel bars, cut true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.
 - 1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
- C. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch (1.2908 mm) in diameter.
- D. Zinc Repair Material: ASTM A780/A780M.

2.3 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Do not cut or puncture vapor retarder.
 - 2. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement.
 - 1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
 - 2. Do not tack weld crossing reinforcing bars.
- C. Preserve clearance between bars of not less than **1 inch (25 mm)**, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.
- D. Provide concrete coverage in accordance with **ACI 318 (ACI 318M)**.
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
 - 1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or **24 inches (610 mm)**, whichever is greater.
 - 2. Stagger splices in accordance with **ACI 318 (ACI 318M)**.
 - 3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
 - 4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.
- G. Install structural thermal break insulated connection system in accordance with manufacturer's instructions.
- H. Install welded-wire reinforcement in longest practicable lengths.
 - 1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."
 - a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed **12 inches (305 mm)**.

2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches (50 mm) for plain wire and 8 inches (200 mm) for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

3.3 JOINTS

- A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 1. Place joints perpendicular to main reinforcement.
 2. Continue reinforcement across construction joints unless otherwise indicated.
 3. Do not continue reinforcement through sides of strip placements of floors and slabs.
- B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

- A. Comply with ACI 117 (ACI 117M).

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
 1. Steel-reinforcement placement.
 2. Steel-reinforcement mechanical splice couplers.
 3. Steel-reinforcement welding.
- D. Manufacturer's Inspections: Engage manufacturer of structural thermal break insulated connection system to inspect completed installations prior to placement of concrete, and to provide written report that installation complies with manufacturer's written instructions.

END OF SECTION 032000

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
2. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.

1.2 DEFINITIONS

- ##### A. Cementitious Materials:
- Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

- ##### B. Water/Cement Ratio (w/cm):
- The ratio by weight of water to cementitious materials.

1.3 ACTION SUBMITTALS

A. Product Data:

For each of the following.

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement
7. Aggregates.
8. Admixtures:
 - a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
9. Fiber reinforcement.
10. Vapor retarders.
11. Floor and slab treatments.
12. Liquid floor treatments.

13. Curing materials.
 14. Joint fillers.
 15. Repair materials.
- B. Sustainable Design Submittals:
1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 2. Laboratory Test Reports: For liquid floor treatments and curing and sealing compounds, indicating compliance with requirements for low-emitting materials.
- C. Design Mixtures: For each concrete mixture, include the following:
1. Mixture identification.
 2. Minimum 28-day compressive strength.
 3. Durability exposure class.
 4. Maximum w/cm.
 5. Calculated equilibrium unit weight, for lightweight concrete.
 6. Slump limit.
 7. Air content.
 8. Nominal maximum aggregate size.
 9. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
 10. Intended placement method.
 11. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- D. Shop Drawings:
1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - a. Location of construction joints is subject to approval of the Architect.
- E. Samples: For vapor retarder.
- F. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:
1. Concrete Class designation.
 2. Location within Project.
 3. Exposure Class designation.
 4. Formed Surface Finish designation and final finish.
 5. Final finish for floors.
 6. Curing process.
 7. Floor treatment if any.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.
3. Testing agency: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Curing compounds.
4. Floor and slab treatments.
5. Bonding agents.
6. Adhesives.
7. Vapor retarders.
8. Semirigid joint filler.
9. Joint-filler strips.
10. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement.
7. Aggregates.
8. Admixtures:

- a. Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.

D. Research Reports:

1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
2. For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.

E. Preconstruction Test Reports: For each mix design.

F. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.
- B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
 1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.
 1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor to be an ACI-certified Concrete Laboratory Testing Technician, Grade II.
- D. Field Quality-Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
 1. Personnel conducting field tests to be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

1.6 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.
 1. Include the following information in each test report:
 - a. Admixture dosage rates.
 - b. Slump.
 - c. Air content.
 - d. Seven-day compressive strength.
 - e. 28-day compressive strength.
 - f. Permeability.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with ASTM C94/C94M and **ACI 301 (ACI 301M)**.

1.8 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with **ACI 301 (ACI 301M)** and ACI 306.1 and as follows.

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 2. When average high and low temperature is expected to fall below **40 deg F (4.4 deg C)** for three successive days, maintain delivered concrete mixture temperature within the temperature range required by **ACI 301 (ACI 301M)**.
 3. Do not use frozen materials or materials containing ice or snow.
 4. Do not place concrete in contact with surfaces less than **35 deg F (1.7 deg C)**, other than reinforcing steel.
 5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with **ACI 301 (ACI 301M)** and **ACI 305.1 (ACI 305.1M)**, and as follows:
1. Maintain concrete temperature at time of discharge to not exceed **95 deg F (35 deg C)**.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.
1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with **ACI 301 (ACI 301M)** unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

- A. Regional Materials: Verify concrete is manufactured within **100 miles (160 km)** of Project site from aggregates and cementitious materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.
- B. Source Limitations:
1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
 2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.

3. Obtain aggregate from single source.
 4. Obtain each type of admixture from single source from single manufacturer.
- C. Cementitious Materials:
1. Portland Cement: ASTM C150/C150M, Type I, gray or white.
 2. Fly Ash: ASTM C618, Class C or F.
 3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
 4. Silica Fume: ASTM C1240 amorphous silica.
- D. Normal-Weight Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.
1. Alkali-Silica Reaction: Comply with one of the following:
 - a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
 - b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
 - c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. (2.37 kg/cu. m) for moderately reactive aggregate or 3 lb./cu. yd. (1.78 kg/cu. m) for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301 (ACI 301M).
 2. Maximum Coarse-Aggregate Size: 3/4 inch (19 mm) nominal.
 3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- E. Air-Entraining Admixture: ASTM C260/C260M.
- F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride in steel-reinforced concrete.
1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 2. Retarding Admixture: ASTM C494/C494M, Type B.
 3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
 5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
- G. Water and Water Used to Make Ice: ASTM C94/C94M, potable or complying with ASTM C1602/C1602M, including all limits listed in Table 2 and the requirements of paragraph 5.4

2.3 VAPOR RETARDERS

- A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than **10 mils (0.25 mm)** thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

2.4 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately **9 oz./sq. yd. (305 g/sq. m)** when dry.
- C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.
 - 1. Color:
 - a. Ambient Temperature Below **50 deg F (10 deg C)**: Black.
 - b. Ambient Temperature between **50 deg F (10 deg C)** and **85 deg F (29 deg C)**: Any color.
 - c. Ambient Temperature Above **85 deg F (29 deg C)**: White.
- D. Curing Paper: **8-feet- (2438-mm-)** wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.
- E. Water: Potable or complying with ASTM C1602/C1602M.
- F. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.
- G. Clear, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.
 - 1. Verify products comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1752, cork or self-expanding cork.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 in accordance with ASTM D2240.
- C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

- D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:
 - 1. Types I and II, nonload bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Floor Slab Protective Covering: ~~8-feet-~~ (2438-mm-) wide cellulose fabric.

2.6 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/8 inch (3 mm)** and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, **1/8 to 1/4 inch (3 to 6 mm)** or coarse sand, as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than [**4100 psi (29 MPa)**] at 28 days when tested in accordance with ASTM C109/C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/4 inch (6 mm)** and that can be filled in over a scarified surface to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
 - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, **1/8 to 1/4 inch (3.2 to 6 mm)** or coarse sand as recommended by topping manufacturer.
 - 4. Compressive Strength: Not less than [**5000 psi (34.5 MPa)**] **<Insert strength>** at 28 days when tested in accordance with ASTM C109/C109M.

2.7 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with **ACI 301 (ACI 301M)**.
 - 1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Other Pozzolans: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Silica Fume: 10 percent by mass.
4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, and concrete with a w/cm below 0.50.

2.8 CONCRETE MIXTURES

A. Class A : Normal-weight concrete used for footings, foundation walls, or piers.

1. Exposure Class: **ACI 318 (ACI 318M) F1**.
2. Minimum Compressive Strength: **3500 psi (24.1 MPa)** at 28 days.
3. Maximum w/cm: 0.55

B. Class B : Normal-weight concrete used for interior slabs-on-ground.

1. Exposure Class: **ACI 318 (ACI 318M) F0**.
2. Minimum Compressive Strength: **3000 psi (20.7 MPa)** at 28 days.
3. Maximum w/cm: 0.45
4. Minimum Cementitious Materials Content: **540 lb/cu. yd. (320 kg/cu. m)**.

C. Class C: Normal-weight concrete used for interior suspended slabs.

1. Exposure Class: **ACI 318 (ACI 318M) F0**.
2. Minimum Compressive Strength: **3000 psi (20.7 MPa)** As indicated at 28 days.
3. Maximum w/cm: 0.45 .
4. Minimum Cementitious Materials Content: **540 lb/cu. yd. (320 kg/cu. m)**.

D. Class D : Normal-weight concrete used for interior metal pan stairs and landings:

1. Exposure Class: **ACI 318 (ACI 318M) F0**.
2. Minimum Compressive Strength: **3000 psi (20.7 MPa)** As indicated at 28 days.
3. Maximum w/cm: 0.45.
4. Minimum Cementitious Materials Content: **470 lb/cu. yd. (279 kg/cu. m)**.
5. Maximum Size Aggregate: **1/2 inch (13 mm)**.
6. Slump Limit: **3 inches (75 mm)**, plus **1 inch (25 mm)** or minus **2 inches (50 mm)**.

7. Air Content: 0 percent
8. Retarding Admixture: Not allowed.
9. Accelerating Admixture: Not allowed.

2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M[and ASTM C1116/C1116M], and furnish batch ticket information.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions:
 1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
 2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:
 1. Daily access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
 4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.
 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
 3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.4 INSTALLATION OF VAPOR RETARDER

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
 2. Face laps away from exposed direction of concrete pour.
 3. Lap vapor retarder over footings and grade beams not less than **6 inches (150 mm)**, sealing vapor retarder to concrete.
 4. Lap joints **6 inches (150 mm)** and seal with manufacturer's recommended tape.
 5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
 6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
 7. Protect vapor retarder during placement of reinforcement and concrete.
 - a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by **6 inches (150 mm)** on all sides, and sealing to vapor retarder.
- B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

3.5 JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
 2. Place joints perpendicular to main reinforcement.
 - a. Continue reinforcement across construction joints unless otherwise indicated.
 - b. Do not continue reinforcement through sides of strip placements of floors and slabs.
 3. Form keyed joints as indicated. Embed keys at least **1-1/2 inches (38 mm)** into concrete.
 4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 5. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 6. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least [one-fourth] of concrete thickness as follows:

1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of **1/8 inch (3.2 mm)**. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch- (3.2-mm-)** wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.
- D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
 2. Terminate full-width joint-filler strips not less than **1/2 inch (13 mm)** or more than **1 inch (25 mm)** below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
 2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.
- B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of **ACI 301 (ACI 301M)**, but not to exceed the amount indicated on the concrete delivery ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.
3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
4. Consolidate placed concrete with mechanical vibrating equipment in accordance with **ACI 301 (ACI 301M)**.
 - a. Do not use vibrators to transport concrete inside forms.
 - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least **6 inches (150 mm)** into preceding layer.
 - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
 - d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.7 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. **ACI 301 (ACI 301M)** Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
 - a. Patch voids larger than **1-1/2 inches (38 mm)** wide or **1/2 inch (13 mm)** deep.
 - b. Remove projections larger than **1 inch (25 mm)**.
 - c. Tie holes do not require patching.
 - d. Surface Tolerance: **ACI 117 (ACI 117M)** Class D.
 - e. Apply to concrete surfaces [not exposed to public view] <Insert locations>.
2. **ACI 301 (ACI 301M)** Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
 - a. Patch voids larger than **3/4 inch (19 mm)** wide or **1/2 inch (13 mm)** deep.
 - b. Remove projections larger than **1/4 inch (6 mm)**.

- c. Patch tie holes.
 - d. Surface Tolerance: **ACI 117 (ACI 117M)** Class B.
 - e. Locations: Apply to concrete surfaces [exposed to public view,] [to receive a rubbed finish,] [or to be covered with a coating or covering material applied directly to concrete] <Insert locations>.
3. **ACI 301 (ACI 301M)** Surface Finish SF-3.0:
- a. Patch voids larger than **3/4 inch (19 mm)** wide or **1/2 inch (13 mm)** deep.
 - b. Remove projections larger than **1/8 inch (3 mm)**.
 - c. Patch tie holes.
 - d. Surface Tolerance: **ACI 117 (ACI 117M)** Class A.
 - e. Locations: Apply to concrete surfaces [exposed to public view,] [to receive a rubbed finish,] [or to be covered with a coating or covering material applied directly to concrete] <Insert locations>.

B. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 FINISHING FLOORS AND SLABS

- A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with **ACI 117 (ACI A117M)** tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish.

C. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface.

5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
7. Finish surfaces to the following tolerances, in accordance with **ASTM E1155 (ASTM E1155M)**, for a randomly trafficked floor surface:
 - a. Slabs on Ground:
 - 1) Finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, **10-ft.- (3.05-m-)** long straightedge resting on two high spots and placed anywhere on the surface does not exceed [**1/4 inch (6 mm)**] [**3/16 inch (4.8 mm)**] [**1/8 inch (3 mm)**] [**1/8 inch (3 mm)**] and also no more than **1/16 inch (1.6 mm)** in **2 feet (610 mm)**].
 - 2) Specified overall values of flatness, F_F 25; and of levelness, F_L 20; with minimum local values of flatness, F_F 17; and of levelness, F_L 15.
 - b. Suspended Slabs:
 - 1) Finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, **10-ft.- (3.05-m-)** long straightedge resting on two high spots and placed anywhere on the surface does not exceed [**1/4 inch (6 mm)**] in **2 feet (610 mm)**.

3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases **4 inches (100 mm)** high unless otherwise indicated on Drawings, and extend base not less than **6 inches (150 mm)** in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: **3000 psi (20.7 MPa)** at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.

5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.
 - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - b. Cast anchor-bolt insert into bases.
 - c. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.

1. Cast-in inserts and accessories, as shown on Drawings.
2. Screed, tamp, and trowel finish concrete surfaces.

3.10 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with **ACI 301 (ACI 301M)** and ACI 306.1 for cold weather protection during curing.
2. Comply with **ACI 301 (ACI 301M)** and **ACI 305.1 (ACI 305.1M)** for hot-weather protection during curing.
3. Maintain moisture loss no more than **0.2 lb/sq. ft. x h (1 kg/sq. m x h)**, calculated in accordance with ACI 305.1, before and during finishing operations.

B. Curing Formed Surfaces: Comply with **ACI 308.1 (ACI 308.1M)** as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
 - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
 - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
 - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
 - d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
 - e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 1) Recoat areas subject to heavy rainfall within three hours after initial application.

- 2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with **ACI 308.1 (ACI 308.1M)** as follows:

1. Begin curing immediately after finishing concrete.
2. Interior Concrete Floors:
 - a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
 - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than **12 inches (300 mm)**.
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
 - 2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least **12 inches (300 mm)**, and sealed by waterproof tape or adhesive.
 - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - b) Cure for not less than seven days.
 - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
 - a) Water.
 - b) Continuous water-fog spray.
 - b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:
 - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than **12 inches (300 mm)**.
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
 - 2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with

sides and ends lapped at least **12 inches (300 mm)**, and sealed by waterproof tape or adhesive.

- a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - b) Cure for not less than seven days.
- 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
- a) Water.
 - b) Continuous water-fog spray.

c. Floors to Receive Urethane Flooring:

- 1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
- 2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped **6 inches (150 mm)** and sealed in place.
- 3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
- 4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.
- 5) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

d. Floors to Receive Curing and Sealing Compound:

- 1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
- 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
- 3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.11 TOLERANCES

- A. Conform to **ACI 117 (ACI 117M)**.

3.12 APPLICATION OF LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than [28] days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
4. Rinse with water; remove excess material until surface is dry.
5. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

3.13 JOINT FILLING

A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least [one] [six] month(s).
2. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints.

D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.14 CONCRETE SURFACE REPAIRS

A. Defective Concrete:

1. Repair and patch defective areas when approved by Architect.
2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension to solid concrete.
 - a. Limit cut depth to 3/4 inch (19 mm).
 - b. Make edges of cuts perpendicular to concrete surface.
 - c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.

- d. Fill and compact with patching mortar before bonding agent has dried.
 - e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
 - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
 - b. Compact mortar in place and strike off slightly higher than surrounding surface.
 3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
 - a. Correct low and high areas.
 - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of **0.01 inch (0.25 mm)** wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
 - a. Finish repaired areas to blend into adjacent concrete.
5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
 - a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 - b. Feather edges to match adjacent floor elevations.
6. Correct other low areas scheduled to remain exposed with repair topping.
 - a. Cut out low areas to ensure a minimum repair topping depth of **1/4 inch (6 mm)** to match adjacent floor elevations.
 - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
7. Repair defective areas, except random cracks and single holes **1 inch (25 mm)** or less in diameter, by cutting out and replacing with fresh concrete.

- a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a **3/4-inch (19-mm)** clearance all around.
 - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
 - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
 - d. Place, compact, and finish to blend with adjacent finished concrete.
 - e. Cure in same manner as adjacent concrete.
8. Repair random cracks and single holes **1 inch (25 mm)** or less in diameter with patching mortar.
- a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
 - b. Dampen cleaned concrete surfaces and apply bonding agent.
 - c. Place patching mortar before bonding agent has dried.
 - d. Compact patching mortar and finish to match adjacent concrete.
 - e. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.
- B. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.
- C. Inspections:
1. Headed bolts and studs.
 2. Verification of use of required design mixture.
 3. Concrete placement, including conveying and depositing.
 4. Curing procedures and maintenance of curing temperature.
 5. Verification of concrete strength before removal of shores and forms from beams and slabs.
 6. Batch Plant Inspections: On a random basis, as determined by Architect.
- D. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
 - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C143/C143M:
 - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - b. Perform additional tests when concrete consistency appears to change.
3. Slump Flow: ASTM C1611/C1611M:
 - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - b. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete;
 - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C1064/C1064M:
 - a. One test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample.
6. Compression Test Specimens: ASTM C31/C31M:
 - a. Cast and laboratory cure two sets of [three] 6-inch (150 mm) by 12-inch (300 mm) or 4-inch (100 mm) by 8-inch (200 mm) cylinder specimens for each composite sample.
7. Compressive-Strength Tests: ASTM C39/C39M.
 - a. Test one set of three laboratory-cured specimens at seven days and one set of three specimens at 28 days.
8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa) if specified compressive strength is less than or equal to 5000 psi (34.5 MPa), or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi (34.5 MPa).
9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

10. Additional Tests:

- a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
 - 1) Acceptance criteria for concrete strength to be in accordance with **ACI 301 (ACI 301M)**, Section 1.6.6.3.

11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

3.16 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 033000

SECTION 042200 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry-joint reinforcement.
5. Embedded flashing.
6. Miscellaneous masonry accessories.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.

1.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. [Type III Environmental Product Declaration \(EPD\)](#): For each product.

C. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of the following:

1. Masonry units.

- a. Include data on material properties.
 - b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
 2. Cementitious materials. Include name of manufacturer, brand name, and type.
 3. Mortar admixtures.
 4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 5. Grout mixes. Include description of type and proportions of ingredients.
 6. Reinforcing bars.
 7. Joint reinforcement.
 8. Anchors, ties, and metal accessories.
- B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
 2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.
- C. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined in accordance with TMS 602/ACI 530.1/ASCE 6.
- D. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified in accordance with ASTM C1093 for testing indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of **24 inches (600 mm)** down both sides of walls, and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.2 PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops indicated net-area compressive strengths at 28 days.
 - 1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with TMS 602/ACI 530.1/ASCE 6.

2.3 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.
- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
 - 1. Where fire-resistance-rated construction is indicated, units are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.4 CONCRETE MASONRY UNITS

- A. **Regional Materials:** Verify CMUs are manufactured within **100 miles (160 km)** of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.
- B. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
 - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 - 2. Provide bullnose units for outside corners unless otherwise indicated.
- C. CMUs: ASTM C90.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of **2800 psi (19.3 MPa)**.
 - 2. Density Classification: Normal weight.
 - 3. Size (Width): Manufactured to dimensions **3/8 inch (10 mm)** less-than-nominal dimensions.

D. Concrete Building Brick: ASTM C55.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi (19.3 MPa).
2. Density Classification: Normal weight.
3. Size (Actual Dimensions): 3-5/8 inches (92 mm) wide by 3-5/8 inches (92 mm) high by 7-5/8 inches (194 mm) long.

2.5 MASONRY LINTELS

A. General: Provide one of the following:

- B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.6 MORTAR AND GROUT MATERIALS

- A. Regional Materials: Manufacture aggregate for mortar and grout within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.
- B. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
1. Alkali content is not more than 0.1 percent when tested in accordance with ASTM C114.
- C. Hydrated Lime: ASTM C207, Type S.
- D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- E. Masonry Cement: ASTM C91/C91M.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Cemex S.A.B. de C.V.
 - b. Holcim (US) Inc.
 - c. Lafarge North America Inc.
 - d. Lehigh Hanson; HeidelbergCement Group.
- F. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than **1/4 inch (6 mm)** thick, use aggregate graded with 100 percent passing the **No. 16 (1.18-mm)** sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

G. Aggregate for Grout: ASTM C404.

H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

I. Water: Potable.

2.7 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, **Grade 60 (Grade 420)**.

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from **0.148-inch (3.77-mm)** steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

C. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A951/A951M.

1. Interior Walls: Hot-dip galvanized carbon steel.
2. Exterior Walls: Hot-dip galvanized carbon steel.
3. Wire Size for Side Rods: **0.187-inch (4.76-mm)** diameter.
4. Wire Size for Cross Rods: **0.187-inch (4.76-mm)** diameter.
5. Spacing of Cross Rods: Not more than **16 inches (407 mm)** o.c.
6. Provide in lengths of not less than **10 feet (3 m)**, with prefabricated corner and tee units.

2.8 TIES AND ANCHORS

A. General: Ties and anchors extend at least **1-1/2 inches (38 mm)** into masonry but with at least a **5/8-inch (16-mm)** cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A153/A153M, Class B-2 coating.
2. Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, **G60 (Z180)** zinc coating.
3. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.

4. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Anchor Section for Welding to Steel Frame: Crimped **1/4-inch- (6.35-mm-)** diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls unless otherwise indicated.
 2. Tie Section: Triangular-shaped wire tie made from diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls unless otherwise indicated.
- D. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
- E. Partition Top Anchors: **0.105-inch- (2.66-mm-)** thick metal plate with a **3/8-inch- (9.5-mm-)** diameter metal rod **6 inches (152 mm)** long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.
- F. Rigid Anchors: Fabricate from steel bars **1-1/2 inches (38 mm)** wide by **1/4 inch (6.35 mm)** thick by **24 inches (610 mm)** long, with ends turned up **2 inches (51 mm)** or with cross pins unless otherwise indicated.
1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A153/A153M.

2.9 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, **0.016 inch (0.40 mm)** thick.
 2. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at **3-inch (76-mm)** intervals along length of flashing to provide an integral mortar bond.
 3. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
 4. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing **1/2 inch (13 mm)** out from wall, with outer edge bent down 30 degrees and hemmed.
 5. Fabricate metal drip edges for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least **3 inches (76 mm)** into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.
 6. Fabricate metal drip edges from stainless steel. Extend at least **3 inches (76 mm)** into wall and **1/2 inch (13 mm)** out from wall, with outer edge bent down 30 degrees and hemmed.

7. Fabricate metal sealant stops from stainless steel. Extend at least **3 inches (76 mm)** into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for **3/4 inch (19 mm)** and down into joint **1/4 inch (6 mm)** to form a stop for retaining sealant backer rod.
8. Solder metal items at corners.

B. Application: Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use metal flashing.
2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a drip edge.
4. Where flashing is fully concealed, use metal flashing.

C. Solder and Sealants for Sheet Metal Flashings:

1. Solder for Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.
2. Elastomeric Sealant: ASTM C920, chemically curing urethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.

D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.10 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805 or PVC, complying with ASTM D2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

2.11 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
 1. Do not use calcium chloride in mortar or grout.

2. Use portland cement-lime mortar unless otherwise indicated.
 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
1. For masonry below grade or in contact with earth, use Type M.
 2. For reinforced masonry, use Type S.
 3. For mortar parge coats, use Type N.
 4. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
 5. For interior nonload-bearing partitions, Type O may be used instead of Type N.
- D. Grout for Unit Masonry: Comply with ASTM C476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
 2. Proportion grout in accordance with ASTM C476, Table 1.
 3. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured in accordance with ASTM C143/C143M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
 2. Verify that foundations are within tolerances specified.
 3. Verify that reinforcing dowels are properly placed.
 4. Verify that substrates are free of substances that would impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Build chases and recesses to accommodate items specified in this and other Sections.
- B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

- 1. For dimensions in cross section or elevation, do not vary by more than plus **1/2 inch (12 mm)** or minus **1/4 inch (6 mm)**.
- 2. For location of elements in plan, do not vary from that indicated by more than plus or minus **1/2 inch (12 mm)**.
- 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus **1/4 inch (6 mm)** in a story height or **1/2 inch (12 mm)** total.

B. Lines and Levels:

- 1. For bed joints and top surfaces of bearing walls, do not vary from level by more than **1/4 inch in 10 feet (6 mm in 3 m)**, or **1/2-inch (12-mm)** maximum.
- 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than **1/8 inch in 10 feet (3 mm in 3 m)**, **1/4 inch in 20 feet (6 mm in 6 m)**, or **1/2-inch (12-mm)** maximum.
- 3. For vertical lines and surfaces do not vary from plumb by more than **1/4 inch in 10 feet (6 mm in 3 m)**, **3/8 inch in 20 feet (9 mm in 6 m)**, or **1/2-inch (12-mm)** maximum.
- 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than **1/8 inch in 10 feet (3 mm in 3 m)**, **1/4 inch in 20 feet (6 mm in 6 m)**, or **1/2-inch (12-mm)** maximum.
- 5. For lines and surfaces, do not vary from straight by more than **1/4 inch in 10 feet (6 mm in 3 m)**, **3/8 inch in 20 feet (9 mm in 6 m)**, or **1/2-inch (12-mm)** maximum.
- 6. For vertical alignment of exposed head joints, do not vary from plumb by more than **1/4 inch in 10 feet (6 mm in 3 m)**, or **1/2-inch (12-mm)** maximum.
- 7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than **1/16 inch (1.5 mm)**.

C. Joints:

- 1. For bed joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3 mm)**, with a maximum thickness limited to **1/2 inch (12 mm)**.
- 2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than **1/8 inch (3 mm)**.

3. For head and collar joints, do not vary from thickness indicated by more than plus **3/8 inch (9 mm)** or minus **1/4 inch (6 mm)**.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3 mm)**.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal **4-inch (100-mm)** horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than **4 inches (100 mm)**. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal **4-inch (100-mm)** horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout **24 inches (600 mm)** under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
 1. Install compressible filler in joint between top of partition and underside of structure above.
 2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide **1/2-inch (13-mm)** clearance between end of anchor rod and end of tube. Space anchors **48 inches (1200 mm)** o.c. unless otherwise indicated.
 3. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Wet joint surfaces thoroughly before applying mortar.
3. Rake out mortar joints for pointing with sealant.

D. Rake out mortar joints at pre-faced CMUs to a uniform depth of **1/4 inch (6 mm)** and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.

E. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

F. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

G. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

3.6 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of **5/8 inch (16 mm)** on exterior side of walls, **1/2 inch (13 mm)** elsewhere. Lap reinforcement a minimum of **6 inches (150 mm)**.

1. Space reinforcement not more than **16 inches (406 mm)** o.c.
2. Space reinforcement not more than **8 inches (203 mm)** o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than **8 inches (203 mm)** above and below wall openings and extending **12 inches (305 mm)** beyond openings[**in addition to continuous reinforcement**].

- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
 - 1. Provide an open space not less than **1/2 inch (13 mm)** wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 - 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
 - 3. Space anchors as indicated, but not more than **24 inches (610 mm)** o.c. vertically and **36 inches (915 mm)** o.c. horizontally.

3.8 CONTROL AND EXPANSION JOINTS

- A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry using one of the following methods:
 - 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
 - 2. Install preformed control-joint gaskets designed to fit standard sash block.
 - 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
 - 4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

3.9 LINTELS

- A. Provide masonry lintels where shown and where openings of more than **12 inches (305 mm)** for brick-size units and **24 inches (610 mm)** for block-size units are shown without structural steel or other supporting lintels.
- B. Provide minimum bearing of **8 inches (200 mm)** at each jamb unless otherwise indicated.

3.10 FLASHING

- A. General: Install embedded flashing at ledges and other obstructions to downward flow of water in wall where indicated.
- B. Install flashing as follows unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 - 2. At lintels, extend flashing a minimum of **6 inches (150 mm)** into masonry at each end. At heads and sills, extend flashing **6 inches (150 mm)** at ends and turn up not less than **2 inches (50 mm)** to form end dams.
 - 3. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than **1-1/2 inches (38 mm)** or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 - 4. Install metal drip edges with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
- C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

3.11 REINFORCED UNIT MASONRY

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 - 1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 - 2. Limit height of vertical grout pours to not more than **60 inches (1520 mm)** **<Insert height>**.

3.12 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements is done at Contractor's expense.
- B. Inspections: Special inspections in accordance with Level C in TMS 402/ACI 530/ASCE 5.
 - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
 - 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
 - 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Testing Prior to Construction: One set of tests.
- D. Testing Frequency: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area or portion thereof.
- E. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.
- F. Mortar Test (Property Specification): For each mix provided, in accordance with ASTM C780. Test mortar for mortar air content and compressive strength.
- G. Grout Test (Compressive Strength): For each mix provided, in accordance with ASTM C1019.

3.13 PARGING

- A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch (19 mm). Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.
- B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot (3 mm per 300 mm). Form a wash at top of parging and a cove at bottom.
- C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.14 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent

construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - 5. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.15 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

END OF SECTION 042200

SECTION 042613 - MASONRY VENEER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brick.
2. Mortar materials.
3. Ties and anchors.
4. Embedded flashing.
5. Accessories.
6. Mortar mixes.

B. Products Installed but not Furnished under This Section:

1. Cast-stone trim in masonry veneer.
2. Steel lintels in masonry veneer.
3. Steel shelf angles for supporting masonry veneer.

C. Related Requirements:

1. Section 014339 "Mockups" for integrated exterior mockup requirements.
2. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
3. Section 076200 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

1.2 DEFINITIONS

- A. CMU(s):** Concrete masonry unit(s).

1.3 ACTION SUBMITTALS

- A. Product Data:** For each type of product.

- B. Shop Drawings:** For the following:

1. Masonry Units: Indicate sizes, profiles, coursing, and locations of special shapes.

- C. Samples for Initial Selection:**

1. Colored mortar.
2. Weep/cavity vents.

- D. Samples for Verification:** For each type and color of the following:

1. Clay face brick, in the form of straps of five or more bricks.
2. Special brick shapes.
3. Colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.
4. Weep/cavity vents.
5. Accessories embedded in masonry.

E. Sustainable Design Submittals:

1. Regional materials

1.4 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

1. Submittal is for information only. Receipt of list does not constitute approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

B. Material Certificates: For each type and size of the following:

1. Masonry units.
 - a. Include data on material properties.
 - b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 - c. For exposed brick, include test report for efflorescence in accordance with ASTM C67/C67M.
 - d. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing in accordance with ASTM C67/C67M or a list of addresses of buildings in Project's area where proposed brick has been used successfully and with a history of durability.
2. Cementitious materials. Include name of manufacturer, brand name, and type.
3. Mortar admixtures.
4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
5. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.

D. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.5 MOCKUPS

- A. Wall Mockups: Build mockups to verify selections made under Sample submittals and to set quality standards for installation. See Section 014339 "Mockups" for additional construction requirements for integrated exterior mockups.
1. Build mockups for typical exterior wall in sizes approximately **60 inches (1524 mm)** long by **72 inches (1829 mm)** high by full thickness, including face and backup wythes and accessories.
 - a. Include a sealant-filled joint at least **16 inches (406 mm)** long in mockup.
 - b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately **12 inches (305 mm)** wide by **16 inches (406 mm)** high.
 - c. Include through-wall flashing installed for a **24-inch (610-mm)** length in corner of exterior wall mockup approximately **16 inches (406 mm)** down from top of mockup, with a **12-inch (305-mm)** length of flashing left exposed to view (omit masonry above half of flashing).
 - d. Include metal studs, sheathing, air barrier, veneer anchors, flashing, cavity drainage material, and weep holes in exterior masonry-veneer wall mockup.
 2. Clean exposed faces of mockups with masonry cleaner as indicated.
 3. Protect accepted mockups from the elements with weather-resistant membrane.
 4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of veneer, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of **24 inches (610 mm)** down face of veneer, and hold cover securely in place.
- B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry. Immediately remove grout, mortar, and soil that come in contact with masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. For exposed masonry units and cementitious mortar components, obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602, except as modified by requirements in the Contract Documents.
- B. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, use the equivalent thickness method for masonry units in accordance with ACI 216.1.

2.3 BRICK

- A. **Regional Materials:** Verify brick is manufactured within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.
- B. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units.
 1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including corners, movement joints, bond beams, sashes, and lintels where shapes produced by sawing would result in sawed surfaces being exposed to view.
- C. Clay Face Brick: Facing brick complying with ASTM C216, Grade SW, Type FBS.
 1. **Glen-Gery 53-DD or approved equal**
 2. Initial Rate of Absorption: Less than **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M.
 3. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
 4. Surface Coating: Brick with colors or textures produced by application of coatings withstand 50 cycles of freezing and thawing in accordance with ASTM C67/C67M with no observable difference in the applied finish when viewed from **10 ft. (3 m)** or have a history of successful use in Project's area.
 5. Size (Actual Dimensions): **3-5/8 inches (92 mm)** wide by **2-1/4 inches (57 mm)** high by **7-5/8 inches (194 mm)** long.
 6. Application: Use where brick is exposed unless otherwise indicated.

2.4 MORTAR MATERIALS

- A. **Regional Materials:** Manufacture aggregate for mortar and grout[, **cement, and lime**] within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.
- B. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
 1. Alkali content will not be more than 0.1 percent when tested in accordance with ASTM C114.
- C. Hydrated Lime: ASTM C207, Type S.

- D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.
- F. Preblended Dry Mortar Mix: Packaged blend made from portland cement and hydrated lime, sand, and admixtures and complying with ASTM C1714/C1714M.
 - a.
- G. Aggregate for Mortar: ASTM C144.
 - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 - 2. For joints less than **1/4 inch (6.4 mm)** thick, use aggregate graded with 100 percent passing the **No. 16 (1.18-mm)** sieve.
 - 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
 - 4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
- I. Water: Potable.

2.5 TIES AND ANCHORS

- A. General: Ties and anchors extend at least **1-1/2 inches (38 mm)** into veneer but with at least a **5/8-inch (16-mm)** cover on outside face.
- B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
 - 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
 - 2. Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, **G60 (Z180)** zinc coating.
- C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
 - 1. Anchor Section for Welding to Steel Frame: Crimped **1/4-inch- (6.4-mm-)** diameter, hot-dip galvanized steel wire.
 - 2. Tie Section: Triangular-shaped wire tie made from **0.187-inch- (4.76-mm-)** diameter, hot-dip galvanized steel wire.

D. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist a 100 lbf (445 N) load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch (1.6 mm).
2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.1084-inch- (2.75-mm-) thick steel sheet, galvanized after fabrication.
3. Fabricate wire ties from 0.187-inch- (4.76-mm-) diameter, hot-dip galvanized steel wire unless otherwise indicated.
4. Contractor's Option: Unless otherwise indicated, provide any of the adjustable masonry-veneer anchors specified.
5. Masonry-Veneer Anchors; Vertical Slotted L-Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting vertical leg with slotted hole for wire tie.
6. Masonry-Veneer Anchors; Double-Pintle Plate: Rib-stiffened, sheet metal anchor section with screw holes at top and bottom, projecting horizontal leg with slots for vertical legs of double pintle wire tie.
7. Masonry-Veneer Anchors; Slotted Plate: Sheet metal anchor section, with screw holes at top and bottom; and raised rib-stiffened strap, stamped into center to provide a slot between strap and base for wire tie. Use self-adhering tape to seal penetration behind anchor plate.
 - a.
8. Masonry-Veneer Anchors; Slotted Plate with Prongs: Sheet metal anchor section, with screw holes at top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation; and raised rib-stiffened strap, stamped into center to provide a slot between strap and base for wire tie. Use self-adhering tape to seal penetration behind anchor plate.
 - a.
9. Masonry-Veneer Anchors; Single-Barrel Screw: Self-drilling, single-barrel screw designed to receive wire tie. Screw has a smooth barrel the same thickness as insulation with factory-installed gasketed washer to seal at face of insulation and sheathing.
10. Masonry-Veneer Anchors; Single-Barrel Screw with Double-Pintle Wingnut: Self-drilling, single-barrel screw with thermally resistant clip designed to receive double-pintle wire tie. Screw has a smooth barrel the same thickness as insulation with factory-installed gasketed washer to seal at face of insulation and sheathing.
11. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 (4.83 mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours in accordance with ASTM B117.

2.6 EMBEDDED FLASHING

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, **0.016 inch (0.40 mm)** thick.
2. Fabricate continuous flashings in sections **96 inches (2438 mm)** long minimum, but not exceeding **12 ft. (3.7 m)**. Provide splice plates at joints of formed, smooth metal flashing.
3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at **3-inch (76-mm)** intervals along length of flashing to provide an integral mortar bond.
4. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
5. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing **1/2 inch (13 mm)** out from wall, with outer edge bent down 30 degrees and hemmed.
6. Fabricate through-wall flashing with sealant stop where indicated. Fabricate by bending metal back on itself **3/4 inch (19 mm)** at exterior face of wall and down into joint **1/4 inch (6.4 mm)** to form a stop for retaining sealant backer rod.
7. Fabricate metal drip edges from stainless steel. Extend at least **3 inches (76 mm)** into wall and **1/2 inch (13 mm)** out from wall, with outer edge bent down 30 degrees and hemmed.
8. Fabricate metal sealant stops from stainless steel. Extend at least **3 inches (76 mm)** into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for **3/4 inch (19 mm)** and down into joint **1/4 inch (6.4 mm)** to form a stop for retaining sealant backer rod.
9. Fabricate metal expansion-joint strips from stainless steel to shapes indicated.
10. Solder metal items at corners.

B. Flexible Flashing: Use the one of following unless otherwise indicated:

1. Stainless Steel Fabric Flashing: Composite, flashing product consisting of **2 mil (0.05 mm)** of Type 304 stainless steel sheet, bonded to a layer of polymeric fabric, to produce an overall thickness of **40 mil (1.0 mm)**.
2. Self-Adhering, Stainless Steel Fabric Flashing: Composite, flashing product consisting of **2 mil (0.05 mm)** of Type 304 stainless steel sheet, bonded to a layer of polymeric fabric with a butyl adhesive, to produce an overall thickness of **10 mil (0.25 mm)** or **40 mil (1.0 mm)** according to application.
 - a.
 - b. Applications: Use **10-mil- (0.25-mm-)** thick flashing at windows, doors, and small wall penetrations; not at base of walls. Use **40-mil- (1.0-mm-)** thick flashing at base of walls.

C. Drainage Plane Flashing: Fabricate from [**stainless steel**] [**copper**] [**rubberized asphalt**] [**elastomeric membrane**] and drainage membrane to shapes indicated, **including weep tabs, termination bar and drip edge**. Provide flashing materials as follows:

1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.016 inch (0.40 mm) thick.
 2. Fabricate continuous flashings in sections 60 inches (1524 mm) long, minimum.
 3. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.
- D. Solder and Sealants for Sheet Metal Flashings:
1. Elastomeric Sealant: ASTM C920, chemically curing urethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.
- E. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.
- F. Termination Bars for Flexible Flashing, Flanged: Stainless steel sheet 0.019 inch by 1-1/2 inches (0.48 mm by 38 mm) with a 3/8-inch (10-mm) flange at top.

2.7 ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.
- B. Weep/Vent Products: Use the one of following unless otherwise indicated:
1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3.2 mm) less than depth of outer wythe, in color selected from manufacturer's standard.
 - a.
 2. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch (3.2 mm) less than depth of outer wythe; in color selected from manufacturer's standard.
 3. Vinyl Weep Hole/Vent: Units made from flexible PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color selected by Architect.
- C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
1. Mortar Deflector: Strips, full depth of cavity and 10 inches (254 mm) high, with dovetail-shaped notches that prevent clogging with mortar droppings.
- D. Offset Angle Supports: Steel plate brackets anchored to structure, allowing continuous insulation behind shelf angle supporting veneer. Component and anchor size and spacing engineered by manufacturer.

- E. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.8 MORTAR MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Use portland cement-lime mortar unless otherwise indicated.
 - 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Use Type N unless another type is indicated.
 - 1. For masonry below grade or in contact with earth, use Type M.
- D. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
 - 1. Mix to match Architect's sample.
 - 2. Application: Use colored-aggregate mortar for exposed mortar joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

- B. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- C. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.
- D. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.
- E. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds **30 g/30 sq. in. (30 g/194 sq. cm)** per minute when tested in accordance with ASTM C67/C67M. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

- 1. For dimensions in cross section or elevation, do not vary by more than plus **1/2 inch (13 mm)** or minus **1/4 inch (6.4 mm)**.
- 2. For location of elements in plan, do not vary from that indicated by more than plus or minus **1/2 inch (13 mm)**.
- 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus **1/4 inch (6.4 mm)** in a story height or **1/2 inch (13 mm)** total.

B. Lines and Levels:

- 1. For bed joints and top surfaces of bearing walls, do not vary from level by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, or **1/2-inch (13-mm)** maximum.
- 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than **1/8 inch in 10 ft. (3.2 mm in 3 m)**, **1/4 inch in 20 ft. (6.4 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
- 3. For vertical lines and surfaces, do not vary from plumb by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, **3/8 inch in 20 ft. (10 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
- 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than **1/8 inch in 10 ft. (3.2 mm in 3 m)**, **1/4 inch in 20 ft. (6.4 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
- 5. For lines and surfaces, do not vary from straight by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, **3/8 inch in 20 ft. (10 mm in 6 m)**, or **1/2-inch (13-mm)** maximum.
- 6. For vertical alignment of exposed head joints, do not vary from plumb by more than **1/4 inch in 10 ft. (6.4 mm in 3 m)**, or **1/2-inch (13-mm)** maximum.
- 7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than **1/16 inch (1.6 mm)** except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

- 1. For bed joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3.2 mm)**, with a maximum thickness limited to **1/2 inch (13 mm)**.

2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than **1/8 inch (3.2 mm)**.
3. For head and collar joints, do not vary from thickness indicated by more than plus **3/8 inch (10 mm)** or minus **1/4 inch (6.4 mm)**.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3.2 mm)**. Do not vary from adjacent bed-joint and head-joint thicknesses by more than **1/8 inch (3.2 mm)**.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than **1/16 inch (1.6 mm)** from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal **4-inch (102-mm)** horizontal face dimensions at corners or jambs.
- C. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- E. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

3.5 MORTAR BEDDING AND JOINTING

- A. Lay masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- B. Set cast-stone trim units in full bed of mortar with full vertical joints.
 1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
 2. Allow cleaned surfaces to dry before setting.
 3. Wet joint surfaces thoroughly before applying mortar.
 4. Rake out mortar joints for pointing with sealant.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
 1. For glazed masonry units, use a nonmetallic jointer **3/4 inch (19 mm)** or more in width.

3.6 ANCHORED MASONRY VENEERS

- A. Anchor masonry veneers to wall framing and concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:
1. Fasten screw-attached anchors through sheathing to wall framing with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 2. Embed tie sections connector sections and continuous wire in masonry joints.
 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 4. Space anchors as indicated, but not more than **18 inches (457 mm)** o.c. vertically and **24 inches (610 mm)** o.c. horizontally, with not less than one anchor for each **2 sq. ft. (0.2 sq. m)** of wall area. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **8 inches (203 mm)**, around perimeter.
 5. Space anchors as indicated, but not more than **16 inches (406 mm)** o.c. vertically and **25 inches (635 mm)** o.c. horizontally, with not less than one anchor for each **[2.67 sq. ft. (0.25 sq. m)] [3.5 sq. ft. (0.33 sq. m)]** of wall area. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **36 inches (914 mm)**, around perimeter.
 6. Space anchors as indicated, but not more than **18 inches (457 mm)** o.c. vertically and horizontally. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **24 inches (610 mm)**, around perimeter.
- B. Provide not less than **1 inch (25 mm)** of airspace between back of masonry veneer and face of insulation.
1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete to comply with the following:
1. Provide an open space not less than **[1/2 inch (13 mm)] [1 inch (25 mm)] [2 inches (51 mm)]** wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
 3. Space anchors as indicated, but not more than **24 inches (610 mm)** o.c. vertically and **36 inches (914 mm)** o.c. horizontally.

3.8 LINTELS

- A. Install steel lintels where indicated.

- B. Provide offset angle supports where indicated and where openings of more than **12 inches (305 mm)** for brick-size units and **24 inches (610 mm)** for block-size units are indicated without structural steel or other supporting lintels.
- C. Provide minimum bearing of **8 inches (203 mm)** at each jamb unless otherwise indicated.

3.9 FLASHING, WEEP HOLES, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
- B. Install flashing as follows unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 - 2. Extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least **8 inches (203 mm)**; with upper edge tucked under air barrier, lapping at least **4 inches (102 mm)**. Fasten upper edge of flexible flashing to sheathing through termination bar.
 - 3. At lintels and shelf angles, extend flashing **6 inches (152 mm)** minimum, to edge of next full unit at each end. At heads and sills, extend flashing **6 inches (152 mm)** minimum, to edge of next full unit and turn ends up not less than **2 inches (51 mm)** to form end dams.
 - 4. Install metal drip edges with sawtooth sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 - 5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch (13 mm)** back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
 - 6. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch (13 mm)** back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
 - 7. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install reglets and nailers for flashing and other related construction where they are indicated to be built into masonry.
- D. Install weep holes in veneers in head joints of first course of masonry immediately above embedded flashing.
 - 1. Use specified weep/cavity vent products to form weep holes.
 - 2. Space weep holes **24 inches (610 mm)** o.c. unless otherwise indicated.
 - 3. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
 - 4. Trim wicking material flush with outside face of wall after mortar has set.

- E. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Accessories" Article.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements will be at Contractor's expense.
- B. Inspections: Special inspections in accordance with Level 2 in TMS 402.
 - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
- C. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.
- D. Mortar Test (Property Specification): For each mix provided, in accordance with ASTM C780. Test mortar for mortar air content and compressive strength.

3.11 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.

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PA-745-210-001

5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

3.12 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION 042613

SECTION 047200 - CAST STONE MASONRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Trim units.
 2. Mortar materials.
 3. Accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. For cast stone units, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Sustainable Design Submittals:
1. Regional Materials: Manufacture cast stone units within 100 miles (160 km) of Project site from aggregates that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.
- C. Shop Drawings: Show fabrication and installation details for cast stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.
1. Include building elevations showing layout of units and locations of joints and anchors.
- D. Samples for Initial Selection: For colored mortar.
- E. Samples for Verification:
1. For each color and texture of cast stone required, 4 inches (100 mm) square in size.
 2. For each trim shape required, 4 inches (100 mm) in length.
 3. For colored mortar, make Samples using same sand and mortar ingredients to be used on Project.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Material Test Reports: For each mix required to produce cast stone, based on testing according to ASTM C1364.
1. Provide test reports based on testing within previous six months.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer of cast stone units similar to those indicated for this Project, that has sufficient production capacity to manufacture required units, and is a plant certified by CSI or APA.
- B. Furnish cast stone for installation in mockups specified in Section 042613 "Masonry Veneer."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate delivery of cast stone with unit masonry work to avoid delaying the Work.
- B. Pack, handle, and ship cast stone units in suitable packs or pallets.
 - 1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units if required, using dollies with wood supports.
 - 2. Store cast stone units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.
- C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- D. Store mortar aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

1.6 PROJECT CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Comply with cold-weather construction requirements in TMS 602.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and above and will remain so until cast stone has dried, but no fewer than seven days after completing cleaning.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements in TMS 602.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Cast Stone: Obtain cast stone units from single source from single manufacturer.

- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

2.2 CAST STONE MATERIALS

- A. General: Comply with ASTM C1364.
- B. Portland Cement: ASTM C150/C150M, Type I or Type III, containing not more than 0.60 percent total alkali when tested according to ASTM C114. Provide natural color or white cement as required to produce cast stone color indicated.
- C. Coarse Aggregates: Granite, quartz, or limestone complying with ASTM C33/C33M; gradation and colors as needed to produce required cast stone textures and colors.
- D. Fine Aggregates: Natural sand or crushed stone complying with ASTM C33/C33M, gradation and colors as needed to produce required cast stone textures and colors.
- E. Admixtures: Use only admixtures specified or approved in writing by Architect.
 - 1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.
 - 2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.
 - 3. Air-Entraining Admixture: ASTM C260/C260M. Add to mixes for units exposed to the exterior at manufacturer's prescribed rate to result in an air content of 4 to 6 percent, except do not add to zero-slump concrete mixes.
 - 4. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 - 5. Water-Reducing, Retarding Admixture: ASTM C494/C494M, Type D.
 - 6. Water-Reducing, Accelerating Admixture: ASTM C494/C494M, Type E.
- F. Reinforcement:
 - 1. Deformed steel bars complying with ASTM A615/A615M, **Grade 40 (Grade 280)**. Use galvanized or epoxy-coated reinforcement when covered with less than **1-1/2 inches (38 mm)** of cast stone material.
 - a. Epoxy Coating: ASTM A775/A775M.
 - b. Galvanized Coating: ASTM A767/A767M.
 - 2. Galvanized-Steel, Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from galvanized-steel wire into flat sheets.
 - 3. Fiber Reinforcement: ASTM C1116/C1116M.
- G. Embedded Anchors and Other Inserts: Fabricated from stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666, Type 304.

2.3 CAST STONE UNITS

- A. **Regional Materials:** Manufacture cast stone units within **100 miles (160 km)** of Project site from aggregates that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.
- B. Cast Stone Units: Comply with ASTM C1364.
 - 1. Units are manufactured using the manufacturer's selected method.
 - 2. Trim units including window sills and other items as indicated on Drawings.
- C. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.
 - 1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.
 - 2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.
 - 3. Provide drips on projecting elements unless otherwise indicated.
- D. Fabrication Tolerances:
 - 1. Variation in Cross Section: Do not vary from indicated dimensions by more than **1/8 inch (3 mm)**.
 - 2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or **1/8 inch (3 mm)**, whichever is greater, but in no case by more than **1/4 inch (6 mm)**.
 - 3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or **1/8 inch (3 mm)**, whichever is greater.
 - 4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than **1/8 inch (3 mm)** on formed surfaces of units and **3/8 inch (10 mm)** on unformed surfaces.
- E. Cure Units as Follows:
 - 1. Cure units in enclosed, moist curing room at 95 percent relative humidity and temperature of **100 deg F (38 deg C)** for 12 hours or **70 deg F (21 deg C)** for 16 hours.
 - 2. Keep units damp and continue curing to comply with one of the following:
 - a. No fewer than five days at mean daily temperature of **70 deg F (21 deg C)** or above.
 - b. No fewer than seven days at mean daily temperature of **50 deg F (10 deg C)** or above.
- F. Acid etch units after curing to remove cement film from surfaces to be exposed to view.
- G. Colors and Textures: As selected by Architect from manufacturer's full range.

2.4 MORTAR MATERIALS

- A. Provide mortar materials that comply with Section 042613 "Masonry Veneer."
- B. Regional Materials: Manufacture aggregate for mortar and grout within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

2.5 ACCESSORIES

- A. Anchors: Type and size indicated, fabricated from Type 304 stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666.
- B. Dowels: 1/2-inch- (12-mm-) diameter round bars, fabricated from Type 304 stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666.
- C. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cast stone manufacturer and expressly approved by cleaner manufacturer for use on cast stone and adjacent masonry materials.

2.6 MORTAR MIXES

- A. Comply with requirements in Section 042613 "Masonry Veneer" for mortar mixes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SETTING CAST STONE IN MORTAR

- A. Set cast stone as indicated in TMS 604.
- B. Install cast stone units to comply with requirements in Section 042613 "Masonry Veneer."
- C. Set cast stone as indicated on Drawings. Set units accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.
 - 1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.

2. Coordinate installation of cast stone with installation of flashing specified in other Sections.
- D. Wet joint surfaces thoroughly before applying mortar or setting in mortar.
- E. Set units in full bed of mortar with full head joints unless otherwise indicated.
1. Set units with joints **1/4 to 3/8 inch (6 to 10 mm)** wide unless otherwise indicated.
 2. Build anchors and ties into mortar joints as units are set.
 3. Fill dowel holes and anchor slots with mortar.
 4. Fill collar joints solid as units are set.
 5. Build concealed flashing into mortar joints as units are set.
 6. Keep head joints in copings and between other units with exposed horizontal surfaces open to receive sealant.
 7. Keep joints at shelf angles open to receive sealant.
- F. Rake out joints for pointing with mortar to depths of not less than **3/4 inch (19 mm)**. Rake joints to uniform depths with square bottoms and clean sides. Scrub faces of units to remove excess mortar as joints are raked.
- G. Point mortar joints by placing and compacting mortar in layers not greater than **3/8 inch (10 mm)**. Compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.
- H. Tool exposed joints slightly concave when thumbprint hard. Use a smooth plastic jointer larger than joint thickness.
- I. Rake out joints for pointing with sealant to depths of not less than **3/4 inch (19 mm)**. Scrub faces of units to remove excess mortar as joints are raked.
- J. Point joints with sealant to comply with applicable requirements in Section 079200 "Joint Sealants."
1. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.
- K. Provide sealant joints at head joints of copings and other horizontal surfaces; at expansion, control, and pressure-relieving joints; and at locations indicated.
1. Keep joints free of mortar and other rigid materials.
 2. Build in compressible foam-plastic joint fillers where indicated.
 3. Form joint of width indicated, but not less than **3/8 inch (10 mm)**.
 4. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.
 5. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

3.3 INSTALLATION TOLERANCES

- A. Variation from Plumb: Do not exceed **1/8 inch in 10 ft. (3 mm in 3 m)**, or **1/2 inch (12 mm)** maximum.
- B. Variation from Level: Do not exceed **1/8 inch in 10 ft. (3 mm in 3 m)**, or **1/2 inch (12 mm)** maximum.
- C. Variation in Joint Width: Do not vary joint thickness more than **1/8 inch in 36 inches (3 mm in 900 mm)** or one-fourth of nominal joint width, whichever is less.
- D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than **1/16 inch (1.5 mm)**, except where variation is due to warpage of units within tolerances specified.

3.4 ADJUSTING AND CLEANING

- A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved by Architect.
- B. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.
- C. In-Progress Cleaning: Clean cast stone as work progresses.
 - 1. Remove mortar fins and smears before tooling joints.
 - 2. Remove excess sealant immediately, including spills, smears, and spatter.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed cast stone as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample; leave one sample uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of cast stone.
 - 3. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
 - 5. Clean cast stone by methods described in Cast Stone Institute Technical Bulletin #39.
 - 6. Clean cast stone with proprietary acidic cleaner applied according to manufacturer's written instructions.

END OF SECTION 047200

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel materials.
2. Shrinkage-resistant grout.
3. Shear stud connectors.

B. Related Requirements:

1. Section 053100 "Steel Decking" for field installation of shear stud connectors through deck.
2. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame miscellaneous steel fabrications and other steel items not defined as structural steel.
3. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting requirements.

1.2 DEFINITIONS

- ##### A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

1.3 COORDINATION

- ##### A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- ##### B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Structural-steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Shear stud connectors.
4. Anchor rods.
5. Threaded rods.

6. Forged-steel hardware.
7. Shop primer.
8. Galvanized-steel primer.
9. Etching cleaner.
10. Galvanized repair paint.
11. Shrinkage-resistant grout.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Health Product Declaration (HPD): For each product.
6. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.

D. Delegated Design Submittal: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data **signed and sealed by the qualified professional engineer responsible for their preparation.**

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and fabricator.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural-steel materials, including chemical and physical properties.

E. Product Test Reports: For the following:

1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
2. Shear stud connectors.

F. Source quality-control reports.

- G. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).
- B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
 - 1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
 - 1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
 - 2. Clean and lubricate bolts and nuts that become dry or rusty before use.
 - 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with applicable provisions of the following specifications and documents:
 - 1. ANSI/AISC 303.
 - 2. ANSI/AISC 360.
 - 3. RCSC's "Specification for Structural Joints Using High-Strength Bolts."
- B. Connection Design Information:

1. Option 3 and 3B: Design connections and final configuration of member reinforcement at connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer.

- a. Use Allowable Stress Design; data are given at service-load level.

C. Moment Connections: Type FR, fully restrained.

D. Construction: Shear wall system

2.2 STRUCTURAL-STEEL MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. W-Shapes: ASTM A992/A992M.

C. Channels, Angles, M-Shapes: ASTM A36/A36M.

D. Channels, Angles, S-Shapes: ASTM A36/A36M.

E. Plate and Bar: ASTM A36/A36M.

F. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B structural tubing.

G. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.

H. Steel Castings: ASTM A216/A216M, Grade WCB, with supplementary requirement S11.

I. Steel Forgings: ASTM A668/A668M.

J. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325 (Grade A325M)**, Type 1, heavy-hex steel structural bolts; **ASTM A563, Grade DH (ASTM A563M, Class 10S)**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

B. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325 (Grade A325M)**, Type 1, heavy-hex steel structural bolts; **ASTM A563, Grade DH (ASTM A563M, Class 10S)**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: Hot-dip zinc coating.

2. Direct-Tension Indicators: ASTM F959/F959M, **Type 325-1 (Type 8.8-1)**, compressible-washer type with mechanically deposited zinc coating finish.

- C. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

- A. Unheaded Anchor Rods: ASTM F1554, Grade 55, weldable
 - 1. Configuration: Straight.
 - 2. Nuts: **ASTM A563 (ASTM A563M) heavy-hex** carbon steel.
 - 3. Plate Washers: ASTM A36/A36M carbon steel.
 - 4. Washers: **ASTM F436 (ASTM F436M)**, Type 1, hardened carbon steel.
 - 5. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.
- B. Headed Anchor Rods: ASTM F1554, Grade 55, weldable, straight.
 - 1. Nuts: **ASTM A563 (ASTM A563M) heavy-hex** carbon steel.
 - 2. Plate Washers: ASTM A36/A36M carbon steel.
 - 3. Washers: **ASTM F436 (ASTM F436M)**, Type 1, hardened carbon steel.
 - 4. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.
- C. Threaded Rods: ASTM A36/A36M
 - 1. Nuts: **ASTM A63 (ASTM A563M)** hex carbon steel.
 - 2. Washers: ASTM A36/A36M carbon steel.
 - 3. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.

2.5 PRIMER

- A. Steel Primer:
 - 1. Comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 - 2. SSPC-Paint 23, latex primer.
 - 3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- B. Galvanized-Steel Primer: MPI#26.
 - 1. Etching Cleaner: MPI#25, for galvanized steel.
 - 2. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.6 SHRINKAGE-RESISTANT GROUT

- A. Metallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

- B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.
 - 1. Camber structural-steel members where indicated.
 - 2. Fabricate beams with rolling camber up.
 - 3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
 - 4. Mark and match-mark materials for field assembly.
 - 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.
- F. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 - 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.8 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.

2.9 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.
1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
 2. Galvanize lintels attached to structural-steel frame and located in exterior walls.

2.10 SHOP PRIMING

- A. Shop prime steel surfaces, except the following:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of **2 inches (50 mm)**.
 2. Surfaces to be field welded.
 3. Surfaces of high-strength bolted, slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 5. Galvanized surfaces.
 6. Corrosion-resisting (weathering) steel surfaces.
 7. Surfaces enclosed in interior construction.
- B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:
1. SSPC-SP 2.
 2. SSPC-SP 3.
- C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner.
- D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of **1.5 mils (0.038 mm)**. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.11 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.
1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

2. Bolted Connections: Inspect shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E165/E165M.
 - b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - c. Ultrasonic Inspection: ASTM E164.
 - d. Radiographic Inspection: ASTM E94/E94M.
4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear stud connector.
 - b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.
5. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
 1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.
- B. Baseplates, Bearing Plates, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of baseplate.
 - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.
- C. Maintain erection tolerances of structural steel within ANSI/AISC 303.
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
- E. Splice members only where indicated.
- F. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.
 - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M[**and AWS D1.8/D1.8M**] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 - 1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

- C. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

3.5 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

- A. Install prefabricated building columns to comply with ANSI/AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

3.6 REPAIR

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting:
 - 1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 - 2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting."

3.7 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:
 - 1. Verify structural-steel materials and inspect steel frame joint details.
 - 2. Verify weld materials and inspect welds.
 - 3. Verify connection materials and inspect high-strength bolted connections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
 - 1. Bolted Connections: Inspect bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
 - 2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.
 - a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - 1) Liquid Penetrant Inspection: ASTM E165/E165M.

- 2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - 3) Ultrasonic Inspection: ASTM E164.
 - 4) Radiographic Inspection: ASTM E94/E94M.
3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
- a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 - b. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

END OF SECTION 051200

SECTION 052100 - STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. K-series steel joists.
2. KCS-type K-series steel joists.
3. Steel joist accessories.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing bearing plates in concrete.
2. Section 042000 "Unit Masonry" for installing bearing plates in unit masonry.
3. Section 051200 "Structural Steel Framing" for field-welded shear connectors.

1.2 DEFINITIONS

- A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."
- B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of joist, accessory, and product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Health Product Declaration (HPD): For each product.
6. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.

3. Indicate locations and details of bearing plates to be embedded in other construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and professional engineer.
- B. Welding certificates.
- C. Manufacturer certificates.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- E. Mill Certificates: For each type of bolt.
- F. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.
- G. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."
 1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.
- B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle joists as recommended in SJI's "Specifications."
- B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.7 SEQUENCING

- A. Deliver steel bearing plates to be built into masonry construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated on Drawings.
 - 1. Use ASD; data are given at service-load level
 - 2. Design special joists to withstand design loads with live-load deflections no greater than the following:
 - a. Roof Joists: Vertical deflection of 1/360 of the span.
- B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.2 STEEL JOISTS

- A. K-Series Steel Joist: Manufactured steel joists of type indicated according to "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
 - 1. Joist Type: K-series steel joists and KCS-type K-series steel joists.
 - 2. K-Series Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.
 - 3. Provide holes in chord members for connecting and securing other construction to joists.
 - 4. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated on Drawings, complying with SJI's "Specifications."
 - 5. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated on Drawings, complying with SJI's "Specifications."
 - 6. Camber joists according to SJI's "Specifications."
 - 7. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds **1/4 inch per 12 inches (1:48)**.

2.3 PRIMERS

- A. Primer:
 - 1. SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

2.4 STEEL JOIST ACCESSORIES

- A. Bridging:

1. Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
 2. Schematically indicated. Detail and fabricate according to SJI's "Specifications." Furnish additional erection bridging if required for stability.
 3. Fabricate as indicated on Drawings and according to SJI's "Specifications." Furnish additional erection bridging if required for stability.
- B. Fabricate steel bearing plates from ASTM A36/A36M steel with integral anchorages of sizes and thicknesses indicated on Drawings. Shop prime paint.
- C. Steel bearing plates with integral anchorages are specified in Section 055000 "Metal Fabrications."
- D. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction.
1. Extend ends to within **1/2 inch (13 mm)** of finished wall surface unless otherwise indicated on Drawings.
 2. Finish: Plain, uncoated.
- E. Welding Electrodes: Comply with AWS standards.
- F. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.
- G. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.5 CLEANING AND SHOP PAINTING

- A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.
- B. Do not prime paint joists and accessories.
- C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than **1 mil (0.025 mm)** thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Do not install joists until supporting construction is in place and secured.
- B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written instructions, and requirements in this Section.
 - 1. Before installation, splice joists delivered to Project site in more than one piece.
 - 2. Space, adjust, and align joists accurately in location before permanently fastening.
 - 3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
 - 4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.
- C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
- D. Bolt joists to supporting steel framework using carbon-steel bolts.
- E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.
- F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 REPAIRS

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.
- B. Touchup Painting:
 - 1. Immediately after installation, clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.
 - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 - b. Apply a compatible primer of same type as primer used on adjacent surfaces.
 - 2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Visually inspect field welds according to AWS D1.1/D1.1M.
- C. Visually inspect bolted connections.
- D. Prepare test and inspection reports.

END OF SECTION 052100

SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof deck.
2. Composite floor deck.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 035216 "Lightweight Insulating Concrete" for lightweight insulating concrete fill over steel deck.
3. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
4. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Roof deck.
2. Composite floor deck.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Health Product Declaration (HPD): For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

- C. Test and Evaluation Reports:
 - 1. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
 - a. Power-actuated mechanical fasteners.
 - b. Acoustical roof deck.
 - 2. Research Reports: For steel deck, from ICC-ES showing compliance with the building code.
- D. Field Quality-Control Submittals:
 - 1. Field quality-control reports.
- E. Qualification Statements: For welding personnel and testing agency.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with SDI QA/QC and the following welding codes:
 - 1. AWS D1.1/D1.1M.
 - 2. AWS D1.3/D1.3M.
- B. FM Approvals' RoofNav Listing: Provide steel roof deck evaluated by FM Approvals and listed in its "RoofNav" for Class 1 fire rating and Class 1-90 windstorm ratings. Identify materials with FM Approvals Certification markings.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Store products in accordance with SDI MOC3. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
 - 1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck in accordance with AISI S100.
- B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.
- C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.2 ROOF DECK

- A. Fabrication of Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:
1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 40 (275), G60 (Z180) zinc coating.
 2. Deck Profile: As indicated.
 3. Profile Depth: 1-1/2 inches (38 mm).
 4. Design Uncoated-Steel Thickness: As indicated.
 5. Span Condition: As indicated.
 6. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.3 COMPOSITE FLOOR DECK

- A. Fabrication of Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with SDI C, with the minimum section properties indicated, and with the following:
1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 40, G60 (Z180) zinc coating.
 2. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 40, G60 (Z180) zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard [gray] [white] baked-on, rust-inhibitive primer.
 3. Profile Depth: As indicated.
 4. Design Uncoated-Steel Thickness: As indicated.
 5. Span Condition: As indicated.

2.4 ACCESSORIES

- A. Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of **33,000 psi (230 MPa)**, not less than **0.0359-inch (0.91-mm)** design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of **33,000 psi (230 MPa)**, of same material and finish as deck, and of thickness and profile recommended by SDI standards for overhang and slab depth.
- G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.
- H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
- I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, **0.0747 inch (1.90 mm)** thick, with factory-punched hole of **3/8-inch (9.5-mm)** minimum diameter.
- J. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- K. Flat Sump Plates: Single-piece steel sheet, **0.0747 inch (1.90 mm)** thick, of same material and finish as deck. For drains, cut holes in the field.
- L. Recessed Sump Pans: Single-piece steel sheet, **0.0747 inch (1.90 mm)** thick, of same material and finish as deck, with **3-inch- (76-mm-)** wide flanges and **[level] [sloped]** recessed pans of **1-1/2-inch (38-mm)** minimum depth. For drains, cut holes in the field.
- M. Galvanizing Repair Paint: ASTM A780/A780M.
- N. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories in accordance with SDI C, SDI NC, and SDI RD, as applicable; manufacturer's written instructions; and requirements in this Section.
- B. Install temporary shoring before placing deck panels if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.

- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install in accordance with deck manufacturer's written instructions.
- J. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

3.3 INSTALLATION OF ROOF DECK

- A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than **1-1/2 inches (38 mm)** long, and as follows:
 - 1. Weld Diameter: **5/8 inch (16 mm)**, nominal.
 - 2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space as indicated.
 - 3. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or [**36 inches (1 m)**], and as follows:
 - 1. Mechanically fasten with self-drilling, **No. 10 (4.8-mm-)** diameter or larger, carbon-steel screws.
 - 2. Mechanically clinch or button punch.
 - 3. Fasten with a minimum of **1-1/2-inch- (38-mm-)** long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of **1-1/2 inches (38 mm)**, with end joints as follows:
 - 1. End Joints: Lapped **2 inches (50 mm)** minimum

- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld flanges to top of deck. Space welds not more than **12 inches (300 mm)** apart with at least one weld at each corner.
 - 1. Install reinforcing channels or zees in ribs to span between supports and weld.
- E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels in accordance with deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.
 - 1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.
- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive in accordance with manufacturer's written instructions to ensure complete closure.

3.4 INSTALLATION OF FLOOR DECK

- A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
 - 1. Weld Diameter: **5/8 inch (16 mm)**, nominal.
 - 2. Weld Spacing:
 - a. Weld edge ribs of panels at each support. Space additional welds an average of **16 inches (400 mm)** apart, but not more than **18 inches (460 mm)** apart.
 - b. Space and locate welds as indicated.
 - 3. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or **36 inches (1 m)**, and as follows:
 - 1. Mechanically fasten with self-drilling, **No. 10 (4.8-mm-)** diameter or larger, carbon-steel screws.
 - 2. Mechanically clinch or button punch.
 - 3. Fasten with a minimum of **1-1/2-inch- (38-mm-)** long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of **1-1/2 inches (38 mm)**, with end joints as follows:
 - 1. End Joints: Lapped or butted at Contractor's option.
- D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure in accordance with SDI recommendations unless otherwise indicated.

- E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, in accordance with SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.
- F. Install piercing hanger tabs at **14 inches (355 mm)** apart in both directions, within **9 inches (228 mm)** of walls at ends, and not more than **12 inches (305 mm)** from walls at sides unless otherwise indicated.

3.5 REPAIR

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.
- B. Repair Painting:
 - 1. Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Special inspections and qualification of welding special inspectors for cold-formed steel floor and roof deck in accordance with quality-assurance inspection requirements of SDI QA/QC.
 - a. Field welds will be subject to inspection.
 - 2. Steel decking will be considered defective if it does not pass tests and inspections.
 - 3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 - b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors that are already tested.
- C. Prepare test and inspection reports.

END OF SECTION 053100

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior non-load-bearing wall framing.
2. Soffit framing.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
2. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies, with height limitations.
3. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Cold-formed steel framing materials.
2. Exterior non-load-bearing wall framing.
3. Vertical deflection clips.
4. Single deflection track.
5. Double deflection track.
6. Drift clips.
7. Soffit framing.
8. Post-installed anchors.
9. Power-actuated anchors.
10. Sill sealer gasket.

B. Sustainable Design Submittals:

1. [Product Data](#): For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. [Environmental Product Declaration](#): For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.

2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

D. Delegated Design Submittal: For cold-formed steel framing.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Certificates: For each type of code-compliance certification for studs and tracks.

D. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

E. Research Reports:

1. For nonstandard cold-formed steel framing post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.
2. For sill sealer gasket/termite barrier, showing compliance with ICC-ES AC380.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association, or the Steel Stud Manufacturers Association.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect and store cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling as required in AISI S202.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.
- B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
 1. Design Loads: As indicated on Drawings.
 2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/600 of the wall height.
 3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F (67 deg C).
 4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of L/36 for floors & L/240 for roofs
 5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
- C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing complies with AISI S100 and AISI S240.
- D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

2.2 COLD-FORMED STEEL FRAMING MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Framing Members, General: Comply with AISI S200 and ASTM C955, Section 8 for conditions indicated.
- C. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
 - 1. Grade: **ST50H (ST340H)**.
 - 2. Coating: **G60 (Z180)**
- D. Steel Sheet for Vertical Deflection Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:
 - 1. Grade: As required by structural performance.
 - 2. Coating: **G60 (Z180)**

2.3 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: **0.0428 inch (1.09 mm)**.
 - 2. Flange Width: **1-5/8 inches (41 mm)**, minimum.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: Matching steel studs.
 - 2. Flange Width: **1-1/4 inches (32 mm)**.
- C. Vertical Deflection Clips, Exterior: Manufacturer's standard [**head**] clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
 - 1. Minimum Base-Metal Thickness: **0.0428 inch (1.09 mm)**.
 - 2. Flange Width: **1 inch (25 mm)** plus the design gap for one-story structures and **1 inch (25 mm)** plus twice the design gap for other applications.
- E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
 - a. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm) .
 - b. Flange Width: 1 inch (25 mm) plus the design gap for one-story structures and 1 inch (25 mm) plus twice the design gap for other applications.
2. Inner Track: Of web depth indicated, and as follows:
 - a. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm) .
 - b. Flange Width: equal to sum of outer deflection track flange width plus 1 inch (25 mm).

2.4 SOFFIT FRAMING

- A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
 1. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm).
 2. Flange Width: 1-5/8 inches (41 mm), minimum.

2.5 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
 1. Supplementary framing.
 2. Bracing, bridging, and solid blocking.
 3. Web stiffeners.
 4. Anchor clips.
 5. End clips.
 6. Foundation clips.
 7. Gusset plates.
 8. Stud kickers and knee braces.
 9. Joist hangers and end closures.
 10. Hole-reinforcing plates.
 11. Backer plates.

2.6 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.

- B. Anchor Bolts: ASTM F1554, Grade 55, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153/A153M, Class C.
- C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 ICC-ES AC193 ICC-ES AC58 or ICC-ES AC308 as appropriate for the substrate.
 - 1. Uses: Securing cold-formed steel framing to structure.
 - 2. Type: Torque-controlled expansion anchor Torque-controlled adhesive anchor or adhesive anchor.
 - 3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941 (ASTM F1941M), Class Fe/Zn 5, unless otherwise indicated.
 - 4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless steel bolts, ASTM F593 (ASTM F738M), and nuts, ASTM F594 (ASTM F836M).
- D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.
- F. Welding Electrodes: Comply with AWS standards.

2.7 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A780/A780M MIL-P-21035B or SSPC-Paint 20.
- B. Cement Grout: Portland cement, ASTM C150/C150M, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.
- D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.
- E. Sill Sealer Gasket: Closed-cell neoprene foam, 1/4 inch (6 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

2.8 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
 - 1. Fabricate framing assemblies using jigs or templates.
 - 2. Cut framing members by sawing or shearing; do not torch cut.
 - 3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
 - 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.
- C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of **1/8 inch in 10 feet (1:960)** and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus **1/8 inch (3 mm)** from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of **1/8 inch (3 mm)**.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than **1/4 inch (6 mm)** to ensure a uniform bearing surface on supporting concrete or masonry construction.

- B. Install sill sealer gasket at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding **1/16 inch (1.6 mm)**.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- H. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 INSTALLATION OF EXTERIOR NONLOADBEARING WALL FRAMING

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing: **16 inches (406 mm)**.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single deep-leg deflection tracks and anchor to building structure.
 - 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
 - 3. Connect vertical deflection clips to studs and anchor to building structure.
 - 4. Connect drift clips to cold-formed steel framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than **48 inches (1220 mm)** apart. Fasten at each stud intersection.
 - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within **18 inches (450 mm)** of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
 - 1. Install solid blocking at centers indicated on Shop Drawings.
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLATION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of **1/8 inch in 10 feet (1:960)** and as follows:

1. Space individual framing members no more than plus or minus **1/8 inch (3 mm)** from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.

3.6 REPAIR

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous framing and supports.
2. Shelf angles.
3. Metal ladders.
4. Metal ships' ladders and pipe crossovers.
5. Elevator pit sump covers.
6. Miscellaneous steel trim.
7. Metal bollards.
8. Metal downspout boots.
9. Loose bearing and leveling plates.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
3. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

C. Related Requirements:

1. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
2. Section 051200 "Structural Steel Framing" for steel framing, supports, elevator machine beams, hoist beams, divider beams, door frames, and other steel items attached to the structural-steel framing.
3. Section 077200 "Roof Accessories" for manufactured metal roof walkways and metal roof stairs.

1.2 COORDINATION

- A.** Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B.** Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Nonslip aggregates and nonslip-aggregate surface finishes.
2. Fasteners.
3. Shop primers.
4. Shrinkage-resisting grout.
5. Manufactured metal ladders.
6. Metal ships' ladders and pipe crossovers.
7. Metal bollards.
8. Pipe and downspout guards.
9. Metal downspout boots.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Miscellaneous framing and supports for applications where framing and supports are not specified in other Sections.
2. Elevator machine beams, hoist beams, and divider beams.
3. Steel shapes for supporting elevator door sills.
4. Shelf angles.
5. Metal ladders.
6. Metal ships' ladders and pipe crossovers.
7. Elevator pit sump covers.
8. Metal bollards.
9. Loose steel lintels.

C. Delegated Design Submittals: For ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Sustainable Design Submittals:

1. [Product Data](#): For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. [Environmental product declaration](#).
3. [Health Product Declaration \(HPD\)](#): For each product.
4. [Sourcing of Raw Materials](#): Corporate sustainability report for each manufacturer.

1.4 INFORMATIONAL SUBMITTALS

- A. Mill Certificates: Signed by stainless steel manufacturers, certifying that products furnished comply with requirements.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

- D. Research Reports: For post-installed anchors.
- E. Delegated design engineer qualifications.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design ladders.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
- C. Regional Materials: Manufacture products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.
- D. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- E. Stainless Steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, Type 304.

- F. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 304.
- G. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- H. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
- I. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless steel fasteners for fastening aluminum stainless steel or nickel silver.
 - 2. Provide bronze fasteners for fastening bronze.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, **ASTM A307, Grade A (ISO 898-1, Property Class 4.6)**; with hex nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.
- C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325 (Grade A325M)**, Type 3, heavy-hex steel structural bolts; **ASTM A563, Grade DH3, (ASTM A563M, Class 10S3)** heavy-hex carbon-steel nuts; and where indicated, flat washers.
- D. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, **ASTM F593 (ISO 3506-1)**; with hex nuts, **ASTM F594 (ASTM F836M)**; and, where indicated, flat washers; Alloy Group **1 (A1)**.
- E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- F. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.
- G. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.
- H. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.

2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless steel bolts, ASTM F593 (ISO 3506-1), and nuts, ASTM F594 (ASTM F836M).

2.4 MISCELLANEOUS MATERIALS

- A. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.
- B. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- E. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- F. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, **1/8 by 1-1/2 inches (3.2 by 38 mm)**, with a minimum **6-inch (150-mm)** embedment and **2-inch (50-mm)** hook, not less than **8 inches (200 mm)** from ends and corners of units and **24 inches (600 mm)** o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 1. Fabricate units from slotted channel framing where indicated.
 2. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.7 SHELF ANGLES

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive **3/4-inch (19-mm)** bolts, spaced not more than **6 inches (150 mm)** from ends and **24 inches (600 mm)** o.c., unless otherwise indicated.
 1. Provide mitered and welded units at corners.
 2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately **2 inches (50 mm)** larger than expansion or control joint.

- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
- C. Galvanize and prime shelf angles located in exterior walls.

2.8 METAL LADDERS

A. General:

1. Comply with ANSI A14.3, except for elevator pit ladders.
2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:

1. Space siderails **18 inches (457 mm)** apart unless otherwise indicated.
2. Siderails: Continuous, **3/8-by-2-1/2-inch (9.5-by-64-mm)** steel flat bars, with eased edges.
3. Rungs: **3/4-inch- (19-mm-)** diameter, steel bars.
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
6. Nonslip Surfaces for Steel Ladders: Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
7. Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.
8. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than **1/2 inch (12 mm)** in least dimension.
9. Support each ladder at top and bottom and not more than **60 inches (1500 mm)** o.c. with welded or bolted steel brackets.
10. Galvanize and prime exterior ladders, including brackets.

2.9 ELEVATOR PIT SUMP COVERS

- A. Provide steel angle supports unless otherwise indicated.

2.10 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize and prime miscellaneous steel trim.

2.11 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 40 steel pipe.

1. Cap bollards with **1/4-inch- (6.4-mm-)** thick, steel plate with domed top.
2. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
3. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.

B. Prime steel bollards with zinc-rich primer.

2.12 PIPE AND DOWNSPOUT GUARDS

A. Fabricate downspout guards from **3/8-inch- (9.5-mm-)** thick by **12-inch- (300-mm-)** wide, steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with **2-inch (50-mm)** clearance between pipe and pipe guard. Drill each end for two **3/4-inch (19-mm)** anchor bolts.

B. Galvanize and prime steel downspout guards.

2.13 METAL DOWNSPOUT BOOTS

A. Source Limitations: Obtain downspout boots from single source from single manufacturer.

B. Provide downspout boots made from cast iron in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.

1. Outlet: Vertical, to discharge into pipe.

C. Prime cast-iron downspout boots with zinc-rich primer.

2.14 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize bearing and leveling plates.

C. Prime plates with zinc-rich primer.

2.15 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than **8 inches (200 mm)** unless otherwise indicated.
- C. Galvanize and prime loose steel lintels located in exterior walls.

2.16 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.17 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.18 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - 1. Shop prime with universal shop primer unless zinc-rich primer is indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
 5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

- B. Anchor supports for operable partitions securely to, and rigidly brace from, building structure.

3.3 INSTALLATION OF SHELF ANGLES

- A. Install shelf angles as required to keep masonry level, at correct elevation, and flush with vertical plane.

3.4 INSTALLATION OF METAL LADDERS

- A. Secure ladders to adjacent construction with the clip angles attached to the stringer.
- B. Install brackets as required for securing of ladders welded or bolted to structural steel or built into masonry or concrete.

3.5 INSTALLATION OF ELEVATOR PIT SUMP COVERS

- A. Install tops of elevator sump pit cover plates and frames flush with finished surface. Adjust as required to avoid lippage that could present a tripping hazard.

3.6 INSTALLATION OF MISCELLANEOUS STEEL TRIM

- A. Anchor to concrete construction to comply with manufacturer's written instructions.

3.7 INSTALLATION OF METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
 - 1. Do not fill removable bollards with concrete.
- B. Anchor bollards in place with concrete footings. Center and align bollards in holes **3 inches (75 mm)** above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
- C. Fill bollards solidly with concrete, mounding top surface to shed water.
 - 1. Do not fill removable bollards with concrete.

3.8 INSTALLATION OF PIPE AND DOWNSPOUT GUARDS

- A. Provide pipe guards at exposed vertical pipes in at locations indicated on Drawings where not protected by curbs or other barriers. Install by bolting to wall or column with expansion anchors. Provide four **3/4-inch (19-mm)** bolts at each pipe guard. Mount pipe guards with top edge **26 inches (660 mm)** above driving surface.

3.9 INSTALLATION OF METAL DOWNSPOUT BOOTS

- A. Anchor metal downspout boots to concrete or masonry construction to comply with manufacturer's written instructions.
- B. Secure downspouts terminations to downspouts and substrate per manufacturer's instructions.

3.10 INSTALLATION OF LOOSE BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.11 REPAIRS

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
 - 2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099113 "Exterior Painting."
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

SECTION 055113 - METAL PAN STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preassembled steel stairs with **concrete-filled** treads.

1.2 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for metal stairs.
1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.
 2. Deliver such items to Project site in time for installation.
- C. Coordinate locations of hanger rods and struts with other work so they do not encroach on required stair width and are within fire-resistance-rated stair enclosure.

1.3 ACTION SUBMITTALS

A. Product Data: For metal pan stairs and the following:

1. Shop primer products.
2. Nonslip-aggregate concrete finish.
3. Grout.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental product declaration.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.

- D. Delegated Design Submittal: For stairs, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification.
 - 1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
 - 2. Protect steel members and packaged materials from corrosion and deterioration.
 - 3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.
 - a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stairs, **railings and guards**, including attachment to building construction.
- B. Structural Performance of Stairs: Metal stairs withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft. (4.79 kN/sq. m).
 2. Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
 3. Uniform and concentrated loads need not be assumed to act concurrently.
 4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
 5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch (6.4 mm), whichever is less.
- C. Structural Performance of Railings and Guards: Railings and guards, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 2. Infill of Guards:
 - a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
 - b. Infill load and other loads need not be assumed to act concurrently.

2.2 METALS

- A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
1. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
 2. Regional Materials: Fabricate products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.
- C. Uncoated, Cold-Rolled Steel Sheet: ASTM A1008/A1008M, either commercial steel, Type B, or structural steel, Grade 25 (Grade 170), unless another grade is required by design loads; exposed.
1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
 2. Regional Materials: Fabricate products within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.

- D. Uncoated, Hot-Rolled Steel Sheet: ASTM A1011/A1011M, either commercial steel, Type B, or structural steel, **Grade 30 (Grade 205)**, unless another grade is required by design loads.
 - 1. **Recycled Content**: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
 - 2. **Regional Materials**: Fabricate products within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

- E. Galvanized Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating, either commercial steel, Type B, or structural steel, **Grade 33 (Grade 230)**, unless another grade is required by design loads.
 - 1. **Recycled Content**: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
 - 2. **Regional Materials**: Fabricate products within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered within **100 miles (160 km)** of Project site.

2.3 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls.
 - 1. Select fasteners for type, grade, and class required.

- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.

- C. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.
 - 1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for stairs indicated to be shop primed with zinc-rich primer.

- D. Post-Installed Anchors: chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group **1 (A1)** stainless steel bolts, ASTM F593, and nuts, **ASTM F594 (ASTM F836M)**.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Electrodes: Comply with AWS requirements.
- B. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- C. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer for [interior] [exterior] use; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time.
- D. For galvanized reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.5 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, struts, railings and guards, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
 - 1. Join components by welding unless otherwise indicated.
 - 2. Use connections that maintain structural value of joined pieces.
- B. Assemble stairs, railings, and guards in shop to greatest extent possible.
 - 1. Disassemble units only as necessary for shipping and handling limitations.
 - 2. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated.
 - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Weld connections to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Weld exposed corners and seams continuously unless otherwise indicated.
 - 5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 - No evidence of welded joint.

- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
 - 1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
 - 2. Locate joints where least conspicuous.
 - 3. Fabricate joints that will be exposed to weather in a manner to exclude water.
 - 4. Provide weep holes where water may accumulate internally.

2.6 FABRICATION OF STEEL-FRAMED STAIRS

- A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Architectural Class, unless more stringent requirements are indicated.
- B. Stair Framing:
 - 1. Stringers: Fabricate of steel channels as indicated on Drawings.
 - a. Stringer Size: As required to comply with "Performance Requirements" Article.
 - b. Provide closures for exposed ends of channel and rectangular tube stringers.
 - c. Finish: Shop primed.
 - 2. Platforms: Construct of steel channel headers and miscellaneous framing members as required to comply with "Performance Requirements" Article.
 - a. Provide closures for exposed ends of channel and rectangular tube framing.
 - b. Finish: Shop primed.
 - 3. Weld stringers to headers; weld framing members to stringers and headers.
 - 4. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.
- C. Metal Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than **0.067 inch (1.7 mm)**.
 - 1. Fabricate treads and landing subplatforms of exterior stairs so finished walking surfaces slope to drain.
 - 2. Steel Sheet, Uncoated: Cold-rolled steel sheet.
 - 3. Galvanized Steel Sheet: Galvanized steel sheet, where indicated.
 - 4. Directly weld metal pans to stringers; locate welds on top of subtreads where they will be concealed by concrete fill. Do not weld risers to stringers.
 - 5. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
 - 6. Shape metal pans to include nosing integral with riser.
 - 7. Attach abrasive nosings to risers.
 - 8. At Contractor's option, provide stair assemblies with metal pan subtreads filled with reinforced concrete during fabrication.

2.7 FINISHES

- A. Finish metal stairs after assembly.
- B. Preparation for Shop Priming: Prepare uncoated, ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."
- C. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.
 - 1. For wall-mounted railings, verify locations of concealed reinforcement within gypsum board and plaster assemblies.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL PAN STAIRS

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.
 - 1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
 - 1. Grouted Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates.
 - a. Clean bottom surface of plates.
 - b. Set plates for structural members on wedges, shims, or setting nuts.
 - c. Tighten anchor bolts after supported members have been positioned and plumbed.
 - d. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.

- e. Promptly pack grout solidly between bearing surfaces and plates so no voids remain.
 - 1) Neatly finish exposed surfaces; protect grout and allow to cure.
 - 2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- E. Fit exposed connections accurately together to form hairline joints.
 - 1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
 - 2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
 - 3. Comply with requirements for welding in "Fabrication, General" Article.
- F. Place and finish concrete fill for treads and platforms to comply with Section 033000 "Cast-in-Place Concrete."
 - 1. Install abrasive nosings with anchors fully embedded in concrete.
 - 2. Center nosings on tread width.
- G. Install precast concrete treads with adhesive supplied by manufacturer.
- H. Install precast terrazzo treads according to manufacturer's written instructions.

3.3 REPAIR

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.
- B. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055113

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel railings.

B. Related Requirements:

1. Section 055113 "Metal Pan Stairs" for steel tube railings associated with metal pan stairs.

1.2 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's product lines of mechanically connected railings.
2. Fasteners.
3. Post-installed anchors.
4. Handrail brackets.
5. Shop primer.
6. Intermediate coats and topcoats.
7. Bituminous paint.
8. Nonshrink, nonmetallic grout.
9. Anchoring cement.
10. Metal finishes.
11. Paint products.

B. Sustainable Design Submittals:

1. [Product Data](#): For recycled content, indicating postconsumer and preconsumer recycled content and cost.

- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- D. Delegated Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For delegated design professional engineer.
- B. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.
- B. Structural Performance: Railings, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:
 - a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
 - b. Infill load and other loads need not be assumed to act concurrently.

2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
 1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch (38-mm) clearance from inside face of handrail to finished wall surface.

2.3 STEEL RAILINGS

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- C. Tubing: ASTM A500/A500M (cold formed) or ASTM A513/A513M, Type 5.
- D. Pipe: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
 1. Provide galvanized finish for exterior installations and where indicated.
- E. Plates, Shapes, and Bars: ASTM A36/A36M.
- F. Cast Iron Fittings: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

2.4 FASTENERS

- A. Fastener Materials:
 1. Ungalvanized-Steel Railing Components: Plated steel fasteners complying with ASTM F1941/F1941M, Class Fe/Zn 5 for zinc coating.
 2. Hot-Dip Galvanized Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
 3. Finish exposed fasteners to match appearance, including color and texture, of railings.

- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction and capable of withstanding design loads.
- C. Fasteners for Interconnecting Railing Components:
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
 - 2. Provide Phillips flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.
 - 1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.5 MISCELLANEOUS MATERIALS

- A. Handrail Brackets: Cast iron center of handrail 2-1/2 inches (63.5 mm) from wall.
- B. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.
- C. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint, complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- E. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- F. Intermediate Coats and Topcoats: Provide products that comply with Section 099113 "Exterior Painting," or Section 099123 "Interior Painting" as appropriate.
- G. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- H. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: At exterior locations and where indicated on Drawings, provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.
 1. Clearly mark units for reassembly and coordinated installation.
 2. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately.
 1. Remove burrs and ease edges to a radius of approximately **1/32 inch (1 mm)** unless otherwise indicated.
 2. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water.
 1. Provide weep holes where water may accumulate.
 2. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove flux immediately.
 4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 welds; ornamental quality with no evidence of a welded joint.
- I. Form changes in direction as follows:
 1. By flush bends or by inserting prefabricated flush-elbow fittings.

- J. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- K. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.
- L. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is **1/4 inch (6 mm)** or less.
- M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
 - 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.
 - 1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
 - 2. Coordinate anchorage devices with supporting structure.
- O. For railing posts set in concrete, provide stainless steel sleeves not less than **6 inches (150 mm)** long with inside dimensions not less than **1/2 inch (13 mm)** greater than outside dimensions of post, with metal plate forming bottom closure.
- P. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.7 STEEL AND IRON FINISHES

- A. Galvanized Railings:
 - 1. Hot-dip galvanize exterior steel railings, including hardware, after fabrication.
 - 2. Comply with ASTM A123/A123M for hot-dip galvanized railings.
 - 3. Comply with ASTM A153/A153M for hot-dip galvanized hardware.
 - 4. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
 - 5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner[**and as follows**].
 - 1. Comply with SSPC-SP 16.

- D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, hot-dip galvanize anchors to be embedded in exterior concrete or masonry.
- E. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3.
- F. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1 for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
 - 1. Shop prime uncoated railings with primers specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" unless zinc-rich primer is indicated.
 - 2. Do not apply primer to galvanized surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

- A. Perform cutting, drilling, and fitting required for installing railings.
 - 1. Fit exposed connections together to form tight, hairline joints.
 - 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
 - 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
 - 4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 5. Set posts plumb within a tolerance of **1/16 inch in 3 feet (2 mm in 1 m)**.
 - 6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed **1/4 inch in 12 feet (6 mm in 3.5 m)**.
- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
 - 1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

- A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.

3.4 ANCHORING POSTS

- A. Use stainless steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Form or core-drill holes not less than **5 inches (125 mm)** deep and **3/4 inch (20 mm)** larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
- C. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material.
- D. Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For steel railings, weld flanges to post and bolt to metal supporting surfaces.

3.5 ATTACHING RAILINGS

- A. Anchor railing ends to concrete and masonry with sleeves concealed within brackets on underside of rails connected to railing ends and anchored to wall construction with anchors and bolts.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.
- C. Attach handrails to walls with wall brackets, except where end flanges are used. Provide brackets with **1-1/2-inch (38-mm)** clearance from inside face of handrail and finished wall surface.
 - 1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
 - 2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- D. Secure wall brackets and railing end flanges to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 2. For hollow masonry anchorage, use toggle bolts.
 3. For steel-framed partitions, use hanger or lag bolts set into fire-retardant-treated wood backing between studs. Coordinate with stud installation to locate backing members.
 4. For steel-framed partitions, fasten brackets directly to steel framing or concealed steel reinforcements, using self-tapping screws of size and type required to support structural loads.
- E. Install railing gates level, plumb, and secure for full opening without interference.
1. Attach hardware using tamper-resistant or concealed means.
 2. Adjust hardware for smooth operation.

3.6 REPAIR

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.
2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099123 "Interior Painting."

3.7 CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

3.8 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 055213

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Wood-preservative-treated lumber.
 2. Fire-retardant-treated lumber.
 3. Miscellaneous lumber.
 4. Plywood backing panels.

1.2 DEFINITIONS

- A. Boards or Strips: Lumber of less than **2 inches nominal (38 mm actual)** size in least dimension.
- B. Dimension Lumber: Lumber of **2 inches nominal (38 mm actual)** size or greater but less than **5 inches nominal (114 mm actual)** size in least dimension.
- C. Lumber grading agencies, and abbreviations used to reference them, include the following:
1. NeLMA: Northeastern Lumber Manufacturers' Association.
 2. NLGA: National Lumber Grades Authority.
 3. SPIB: The Southern Pine Inspection Bureau.
 4. WCLIB: West Coast Lumber Inspection Bureau.
 5. WWPA: Western Wood Products Association.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency in accordance with ASTM D5664.
 4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Sustainable Design Submittals:

1. Chain-of-Custody Qualification Data: For manufacturer and vendor.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

1.5 QUALITY ASSURANCE

- A. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.
- B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS

- A. Regional Materials: Manufacture wood products within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.
- B. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.

3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
4. Dress lumber, S4S, unless otherwise indicated.

C. Maximum Moisture Content:

1. Boards: 15 percent.
2. Dimension Lumber: 15 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWWA U1, Use categories as follows:

1. UC2: Interior construction not in contact with ground but may be subject to moisture. Include the following items:
 - a. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.
2. UC3A (Commodity Specification A): Coated sawn products in exterior construction not in contact with ground but exposed to all weather cycles including intermittent wetting. Include the following items:
 - a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
3. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
4. After treatment, redry dimension lumber to 19 percent maximum moisture content.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.

2.3 FIRE-RETARDANT-TREATED LUMBER

A. General: Where fire-retardant-treated materials are indicated, materials are to comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
 - 1. Treatment is not to promote corrosion of metal fasteners.
 - 2. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when tested in accordance with ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
 - 3. Design Value Adjustment Factors: Treated lumber is to be tested according to ASTM D5664 and design value adjustment factors are to be calculated according to ASTM D6841.
- C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. Kiln-dry plywood after treatment to maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency and other information required by authorities having jurisdiction.
 - 1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by testing agency.
- E. For exposed items indicated to receive a stained or natural finish, chemical formulations are not to bleed through, contain colorants, or otherwise adversely affect finishes.
- F. Application: Treat items indicated on Drawings, and the following:
 - 1. Concealed blocking.
 - 2. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

- A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Rooftop equipment bases and support curbs.
 - 4. Cants.
- B. Dimension Lumber Items: Standard, Stud, or No. 3 grade lumber of any species.
- C. Roofing Nailers: Structural- or No. 2-grade lumber or better; kiln-dried Douglas fir, southern pine, or wood having similar decay-resistant properties.
- D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, C-C Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than [1/2-inch (13-mm)] [3/4-inch (19-mm)] nominal thickness.

2.6 FASTENERS

- A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches (38 mm) into wood substrate.
 - 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
- C. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
- D. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- E. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- F. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.10.1, "Fastening Schedule," in ICC's International Building Code (IBC).

- G. Securely attach roofing nailers to substrates by anchoring and fastening to withstand bending, shear, or other stresses imparted by Project wind loads and fastener-resistance loads as designed in accordance with ASCE/SEI 7.
- H. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILERS

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach wood blocking to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Attach wood roofing nailers securely to substrate to resist the designed outward and upward wind loads indicated on Drawings and in accordance with ANSI/SPRI ED-1, Tables A6 and A7.

3.3 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000

SECTION 062023 - INTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior trim.
 - 2. Pegboard paneling.
- B. Related Requirements:
 - 1. Section 055113 "Metal Pan Stairs" for related handrails.
 - 2. Section 061000 "Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Paneling.
- B. Product Data Submittals: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.
- C. Sustainable Design Submittals:
 - 1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
 - 2. Chain-of-Custody Qualification Data: For manufacturer and vendor.
 - 3. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
 - 4. Product Data: For installation adhesives, indicating VOC content.
 - 5. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.
- D. Samples: For each exposed product and for each color and texture specified.

1.3 QUALITY ASSURANCE

- A. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.
- B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation.
 - 1. Protect materials from weather by covering with waterproof sheeting, securely anchored.
 - 2. Provide for air circulation around stacks and under coverings.

- B. Deliver interior finish carpentry materials only when environmental conditions comply with requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions comply with requirements specified for installation areas.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet-work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. **Regional Materials:** Manufacture the following wood products within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.
 - 1. Interior hardboard paneling.
- B. **Certified Wood:** Certify the following wood products as "FSC Pure" or "FSC Mixed Credit" in accordance with FSC STD-01-001 and FSC STD-40-004.
 - 1. Interior hardboard paneling.
- C. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with applicable rules of any rules-writing agency certified by the American Lumber Standard Committee's (ALSC) Board of Review. Grade lumber by an agency certified by the ALSC's Board of Review to inspect and grade lumber under the rules indicated.
- D. Hardboard: ANSI A135.4.
- E. Hardwood Lumber Trim for Transparent Finish (Stain or Clear Finish):
 - 1. Species and Grade: White maple; NHLA Clear.
 - 2. Maximum Moisture Content: 13 percent.
 - 3. Finger Jointing: Not allowed.
 - 4. Face Surface: Surfaced (smooth).
 - 5. Matching: Selected for compatible grain and color.
 - 6. Handrail Profile: Refer to Drawings.

2.2 PANELING

- A. Hardboard Paneling: Interior factory-finished hardboard paneling complying with ANSI A135.5.

1. Type: Tempered hardboard pegboard paneling.
2. Thickness: 1/4 inch.
3. Size: 48 x 96 inches.
4. Hole Pattern: 9/32" holes at 1" o.c. each way.
5. Finish: Brown color, smooth surface one side.
6. Surface-Burning Characteristics: As follows, tested according to ASTM E84:
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.

2.3 MISCELLANEOUS MATERIALS

- A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.
- B. Spacers: Provide metal 1/2" spacers to mount pegboard.
- C. Handrail Brackets: Stainless steel with wall flange drilled and tapped for concealed hanger bolt and with support arm for screwing to underside of rail. Size to provide 1-1/2-inch clearance between handrail and face of wall.
 1. Basis of Design: Model 271 or 243 Carlstadt self-aligning wall bracket by Julius Blum & Co., Inc. Brushed stainless steel finish.
- D. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.
 1. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 2. Verify adhesives have a VOC content of 30 g/L or less.
- E. Paneling Adhesive: Comply with paneling manufacturer's written instructions for adhesives.
 1. Verify adhesives have a VOC content of 50 g/L or less.
 2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- F. Multipurpose Construction Adhesive: Formulation, complying with ASTM D3498, that is recommended for indicated use by adhesive manufacturer.
 1. Verify adhesives have a VOC content of 70 g/L or less.
 2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.
- B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours.

3.3 INSTALLATION, GENERAL

- A. Do not use materials that are unsound; warped; improperly treated or finished; inadequately seasoned; too small to fabricate with proper jointing arrangements; or with defective surfaces, sizes, or patterns.
- B. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials.
 - 1. Use concealed shims where necessary for alignment.
 - 2. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
 - 3. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
 - 4. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining interior finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
 - 5. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.4 INSTALLATION OF INTERIOR TRIM

- A. Install trim with minimum number of joints as is practical, using full-length pieces from maximum lengths of lumber available.
 - 1. Do not use pieces less than 48 inches long, except where necessary.
 - 2. Stagger joints in adjacent and related standing and running trim.
 - 3. Miter at returns, miter at outside corners, and cope at inside corners to produce tight-fitting joints with full-surface contact throughout length of joint.
 - 4. Use scarf joints for end-to-end joints.
 - 5. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
 - 6. Install trim after gypsum-board joint finishing operations are completed.

7. Install without splitting; drill pilot holes before fastening where necessary to prevent splitting.
8. Fasten to prevent movement or warping.
9. Countersink fastener heads on exposed carpentry work and fill holes.

3.5 INSTALLATION OF PANELING

- A. Hardboard Paneling: Install according to manufacturer's written instructions.
 1. Leave 1/4-inch gap to be covered with trim at top, bottom, and openings.
 2. Butt adjacent panels with moderate contact.
 3. Use fasteners with prefinished heads matching paneling color.
 4. Wood Stud or Furring Substrate: Install with 1-inch annular-ring shank hardboard nails.
 5. Nailing: Space nails 4 inches o.c. at panel perimeter and 8 inches o.c. at intermediate supports unless otherwise required by manufacturer.

3.6 ADJUSTING

- A. Replace interior finish carpentry that is damaged or does not comply with requirements.
 1. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.
- B. Adjust joinery for uniform appearance.

3.7 CLEANING

- A. Clean interior finish carpentry on exposed and semiexposed surfaces.
- B. Restore damaged or soiled areas and touch up factory-applied finishes if any.

3.8 PROTECTION

- A. Protect installed products from damage from weather and other causes during construction.
- B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 062023

SECTION 066400 - PLASTIC PANELING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plastic sheet paneling.
- B. Related Requirements:
 - 1. Section 061000 "Rough Carpentry" for wood furring for installing plastic paneling.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. **Product Data:** For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. **Product Data:** For adhesives, indicating VOC content.
 - 3. **Laboratory Test Reports:** For adhesives, indicating compliance with requirements for low-emitting materials.
 - 4. **Product Data:** For sealants, indicating VOC content.
 - 5. **Laboratory Test Reports:** For sealants, indicating compliance with requirements for low-emitting materials.
 - 6. **Laboratory Test Reports:** For wall materials, indicating compliance with requirements for low-emitting materials.
- C. Samples: For plastic paneling, in manufacturer's standard sizes.

1.3 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install plastic paneling until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain plastic paneling and trim accessories from single manufacturer.

2.2 PLASTIC SHEET PANELING

- A. Glass-Fiber-Reinforced Plastic Paneling: Gelcoat-finished, glass-fiber-reinforced plastic panels complying with ASTM D 5319. Panels shall be USDA accepted for incidental food contact.
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

- a. [Crane Composites, Inc.](#)
- b. [Glasteel.](#)
- c. [Marlite.](#)
2. [Verify wall materials comply with](#) the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Surface-Burning Characteristics: As follows when tested by a qualified testing agency according to ASTM E 84. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
4. Nominal Thickness: Not less than 0.09 inch.
5. Surface Finish: Molded pebble texture.
6. Color: Refer to Interior Finish Schedule on Drawing ID001.

2.3 ACCESSORIES

- A. Adhesive: As recommended by plastic paneling manufacturer.
 1. [Verify adhesives have a VOC](#) content of 50 g/L or less.
 2. [Verify adhesive complies with the](#) testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Sealant: Mildew-resistant, single-component, neutral-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Section 079200 "Joint Sealants."
 1. [Verify sealant has a VOC](#) content of 250 g/L or less.
 2. [Verify sealant complies with the](#) testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrate by sanding high spots and filling low spots as needed to provide flat, even surface for panel installation.
- B. Clean substrates of substances that could impair adhesive bond, including oil, grease, dirt, and dust.

- C. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.
- D. Lay out paneling before installing. Locate panel joints to provide equal panels at ends of walls not less than half the width of full panels.
 - 1. Mark plumb lines on substrate at panel joint locations for accurate installation.
 - 2. Locate panel joints to allow clearance at panel edges according to manufacturer's written instructions.

3.3 INSTALLATION

- A. Install plastic paneling according to manufacturer's written instructions.
- B. Install panels in a full spread of adhesive.
- C. Fill grooves between panels, and between panels and adjacent materials with sealant.
- D. Maintain uniform space between panels and wall fixtures. Fill space with sealant.
- E. Maintain uniform space between adjacent panels and between panels and floors, ceilings, and fixtures. Fill space with sealant.
- F. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION 066400

SECTION 071326 - SELF-ADHERING SHEET WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Sheet waterproofing.
 2. Blindside sheet waterproofing.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
 2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.
- B. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, expansion joints, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
1. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Research Reports: For modified bituminous sheet waterproofing/termite barrier, showing compliance with ICC AC380.
- C. Field quality-control reports.
- D. Sample Warranties: For special warranties.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
 - 1. Do not apply waterproofing in snow, rain, fog, or mist.
- B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.6 WARRANTY

- A. Manufacturer's Warranty:
 - 1. Waterproofing Warranty: Manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.
 - a. Warranty Period: Five years from date of Substantial Completion.
- B. Installer's Special Warranty: Specified form, signed by Installer, covering Work of this Section, for warranty period of two years.
 - 1. Warranty includes removing and reinstalling protection board, drainage panels, and insulation.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Source Limitations for Waterproofing System: Obtain waterproofing materials from single source from single manufacturer.

2.2 SHEET WATERPROOFING

- A. Modified Bituminous Sheet Waterproofing: Minimum **60-mil (1.5-mm)** nominal thickness, self-adhering sheet consisting of **56 mils (1.4 mm)** of rubberized asphalt laminated on one side to a **4-mil- (0.10-mm-)** thick, polyethylene-film reinforcement, and with release liner on adhesive side; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Carlisle Coatings & Waterproofing Inc.
 - b. Henry Company.

- c. [MAPEI Corporation.](#)
- d. [Tamko Building Products LLC.](#)
- e. [W. R. Meadows, Inc.](#)

2. Physical Properties:

- a. Tensile Strength, Membrane: **250 psi (1.7 MPa)** minimum; ASTM D412, Die C, modified.
 - b. Ultimate Elongation: 300 percent minimum; ASTM D412, Die C, modified.
 - c. Low-Temperature Flexibility: Pass at **minus 20 deg F (minus 29 deg C)**; ASTM D1970/D1970M.
 - d. Crack Cycling: Unaffected after 100 cycles of **1/8-inch (3-mm)** movement; ASTM C836/C836M.
 - e. Puncture Resistance: **40 lbf (180 N)** minimum; ASTM E154/E154M.
 - f. Water Absorption: 0.2 percent weight-gain maximum after 48-hour immersion at **70 deg F (21 deg C)**; ASTM D570.
 - g. Water Vapor Permeance: **0.05 perm (2.9 ng/Pa x s x sq. m)** maximum; ASTM E96/E96M, Water Method.
 - h. Hydrostatic-Head Resistance: **200 feet (60 m)** minimum; ASTM D5385.
3. Sheet Strips: Self-adhering, rubberized-asphalt strips of same material and thickness as sheet waterproofing.

2.3 BLINDSIDE SHEET WATERPROOFING

A. Blindside Sheet Waterproofing for Vertical Applications: Uniform, flexible, multilayered-composite sheet membrane that forms a permanent bond with fresh concrete placed against it; complete with accessories and preformed shapes for an unbroken waterproofing assembly; with the following physical properties:

1. [Manufacturers:](#) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Carlisle Coatings & Waterproofing Inc.](#)
 - b. [Henry Company.](#)
 - c. [W. R. Meadows, Inc.](#)
2. Physical Properties:
 - a. Low-Temperature Flexibility: Pass at **minus 20 deg F (minus 29 deg C)**; ASTM D1970/D1970M.
 - b. Peel Adhesion to Concrete: **5 lbf/in. (875 N/m)** minimum; ASTM D903, modified.
 - c. Lap Adhesion: **5 lbf/in. (875 N/m)** minimum; ASTM D1876, modified.
 - d. Hydrostatic-Head Resistance: **230 feet (70 m)**; ASTM D5385, modified.
 - e. Puncture Resistance: **100 lbf (445 N)** minimum; ASTM E154/E154M.
 - f. Water Vapor Permeance: **0.1 perm (6 ng/Pa x s x sq. m)** maximum; ASTM E96/E96M, Water Method.
 - g. Ultimate Elongation: 335 percent minimum; ASTM D412, modified.

- B. Blindsight Sheet Waterproofing for Horizontal Applications: Uniform, flexible, multilayered-composite sheet membrane that forms a permanent bond with fresh concrete placed against it; complete with accessories and preformed shapes for an unbroken waterproofing assembly; with the following physical properties:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Carlisle Coatings & Waterproofing Inc.](#)
 - b. [Henry Company.](#)
 - c. [W. R. Meadows, Inc.](#)
 2. Physical Properties:
 - a. Low-Temperature Flexibility: Pass at **minus 20 deg F (minus 29 deg C)**; ASTM D1970/D1970M.
 - b. Peel Adhesion to Concrete: **5 lbf/in. (875 N/m)** minimum; ASTM D903, modified.
 - c. Lap Adhesion: **5 lbf/in. (875 N/m)** minimum; ASTM D1876, modified.
 - d. Hydrostatic-Head Resistance: **230 feet (70 m)**; ASTM D5385, modified.
 - e. Puncture Resistance: **200 lbf (890 N)** minimum; ASTM E154/E154M.
 - f. Water Vapor Permeance: **0.1 perm (6 ng/Pa x s x sq.m)** maximum; ASTM E96/E96M, Water Method.
 - g. Ultimate Elongation: 335 percent minimum; ASTM D412, modified.
- C. Mastic, Adhesives, and Detail Tape: Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.

2.4 ACCESSORIES

- A. Furnish accessory materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
1. Furnish liquid-type accessory materials that comply with VOC limits of authorities having jurisdiction.
- B. Primer: Liquid waterborne primer recommended for substrate by sheet waterproofing material manufacturer.
- C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by sheet waterproofing material manufacturer.
- D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.
- E. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.
- F. Metal Termination Bars: Aluminum bars, approximately **1 by 1/8 inch (25 by 3 mm)**, predrilled at **9-inch (229-mm)** centers.

- G. Protection Course, Extruded-Polystyrene Board Insulation, Faced: Fan folded, faced on [**one side**] [**or**] [**both sides**] with plastic film, nominal thickness **1/4 inch (6 mm)**, with compressive strength of not less than **8 psi (55 kPa)** in accordance with ASTM D1621, and maximum water absorption by volume of 0.6 percent in accordance with ASTM C272/C272M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of waterproofing.
 - 1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
 - 2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.
 - 3. Verify that compacted subgrade is dry, smooth, sound, and ready to receive waterproofing sheet.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections.
- E. Fill form tie holes, honeycomb, aggregate pockets, holes, and other voids.
- F. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks in accordance with ASTM D4258.
 - 1. Install sheet strips of width according to manufacturer's written instructions and center over treated construction and contraction joints and cracks exceeding a width of [**1/16 inch (1.6 mm)**].
- G. Bridge and cover isolation joints, expansion joints, and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips of widths according to manufacturer's written instructions.

1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.
- H. Corners: Prepare, prime, and treat inside and outside corners in accordance with manufacturer's instructions.
 1. Install membrane strips centered over vertical inside corners. Install **3/4-inch (19-mm)** fillets of liquid membrane on horizontal inside corners and as follows:
 - a. At footing-to-wall intersections, extend liquid membrane in each direction from corner or install membrane strip centered over corner.
 - b. At plaza-deck-to-wall intersections, extend liquid membrane or sheet strips onto deck waterproofing and to finished height of sheet flashing.
- I. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions.

3.3 INSTALLATION OF SHEET WATERPROOFING

- A. Install modified bituminous sheets according to waterproofing manufacturer's written instructions.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.
- C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform **2-1/2-inch- (64-mm-)** minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure watertight installation.
 1. When ambient and substrate temperatures range between **25 and 40 deg F (minus 4 and plus 5 deg C)**, install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than **60 deg F (16 deg C)**.
- D. Two-Ply Application: Install sheets to form a membrane with lap widths not less than 50 percent of sheet widths, to provide a minimum of two thicknesses of sheet membrane over areas to receive waterproofing.
- E. Horizontal Application: Apply sheets from low to high points of decks to ensure that laps shed water.
- F. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.
- G. Seal edges of sheet waterproofing terminations with termination bar and sealant.
- H. Install sheet waterproofing and accessory materials to tie into adjacent waterproofing.
- I. Roll waterproofing membrane to firmly adhere to substrate. Roll seams and terminations.

- J. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending **6 inches (150 mm)** beyond repaired areas in all directions.
- K. Immediately install protection course with butted joints over waterproofing membrane.

3.4 INSTALLATION OF BLINDSIDE SHEET WATERPROOFING

- A. Install blindside sheet waterproofing according to manufacturer's written instructions.
- B. Vertical Applications: Install sheet with face against substrate. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required by membrane manufacturer. Overlap and seal seams, and stagger and tape end laps to ensure watertight installation. Mechanically fasten to substrate.
 - 1. Securely fasten top termination of membrane with continuous metal termination bar anchored into substrate and cover with detail tape.
- C. Horizontal Applications: Install sheet with face against substrate. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required by membrane manufacturer. Overlap and seal seams, and stagger and tape end laps to ensure watertight installation.
- D. Corners: Seal lapped terminations and cut edges of sheet waterproofing at inside and outside corners with detail tape.
- E. Seal penetrations through sheet waterproofing to provide watertight seal with detail tape patches or wraps and a liquid-membrane troweling.
- F. Install sheet waterproofing and accessory materials to produce a continuous watertight tie into adjacent waterproofing.
- G. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Tape perimeter of damaged or nonconforming area extending **6 inches (150 mm)** beyond repaired areas in all directions. Apply a patch of sheet waterproofing and firmly secure with detail tape.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests, and to furnish reports to Architect.
- B. Manufacturer's Field Service: Engage asite representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components; and to furnish daily reports to Architect.
- C. Waterproofing will be considered defective if it does not pass tests and inspections.

3.6 PROTECTION, REPAIR, AND CLEANING

- A. Do not permit foot or vehicular traffic on unprotected membrane.
- B. Protect waterproofing from damage and wear during remainder of construction period.
- C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.
- D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 071326

SECTION 071416 - COLD FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Polyurethane waterproofing.
 2. Protection course.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
 2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.
- B. Shop Drawings:
1. Indicate locations and extent of waterproofing.
 2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
- C. Samples: For each exposed product and for each color and texture specified, including the following products:
1. Flashing sheet, **8 by 8 inches** (200 by 200 mm).
 2. Membrane-reinforcing fabric, **8 by 8 inches** (200 by 200 mm).
 3. Drainage panel, **4 by 4 inches** (100 by 100 mm).
- D. Sustainable Design Submittals:
1. [Product data and VOC data](#)

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranties: For special warranties.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer.
 - 1. Do not apply waterproofing to a damp or wet substrate, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.
 - 2. Do not apply waterproofing in snow, rain, fog or mist, or when such weather conditions are imminent during application and curing period.
- B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.6 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace waterproofing that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Installer's Special Warranty: Specified form, signed by Installer, covering Work of this Section, for warranty period of two years.
 - 1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pavers on plaza decks.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain waterproofing materials from single source and from single manufacturer.

2.2 POLYURETHANE WATERPROOFING

- A. Single-Component, Modified Polyurethane Waterproofing: ASTM C836/C836M and coal-tar free.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Carlisle Coatings & Waterproofing Inc.

- b. MAPEI Corporation.
- c. [Tremco Incorporated.](#)

2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials recommended in writing by waterproofing manufacturer for intended use and compatible with one another and with waterproofing.
 - 1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
- B. Primer: Manufacturer's standard primer, sealer, or surface conditioner; factory-formulated.
- C. Sheet Flashing: **50-mil-** (1.3-mm-) minimum, nonstaining, uncured sheet neoprene.
 - 1. Adhesive: Manufacturer's recommended contact adhesive.
- D. Joint Reinforcing Strip: Manufacturer's recommended fiberglass mesh or polyester fabric.
- E. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing; ASTM C920, Type M, Class 25 or greater; Grade NS for sloping and vertical applications and Grade P for deck applications; Use NT exposure; and as recommended by manufacturer for substrate and joint conditions.
 - 1. Backer Rod: Closed-cell polyethylene foam.

2.4 PROTECTION COURSE

- A. Protection Course, Core or Extruded-Polystyrene Board Insulation, Both Sides with Plastic Film: Fan folded, nominal thickness of **1/4 inch (6 mm)**, with compressive strength of not less than **8 psi (55 kPa)** in accordance with ASTM C1621/C1621M and maximum water absorption by volume of 0.6 percent in accordance with ASTM C272/C272M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
 - 2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean, prepare, and treat substrates in accordance with manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.
- D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.
 - 1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate in accordance with ASTM D4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces in accordance with ASTM D4258.
- E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.

3.3 PREPARATION AT TERMINATIONS, PENETRATIONS, AND CORNERS

- A. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners in accordance with waterproofing manufacturer's written instructions and to recommendations in ASTM C898/C898M and ASTM C1471/C1471M.
- B. Apply waterproofing in two separate applications, and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.

3.4 JOINT AND CRACK TREATMENT

- A. Prepare, treat, rout, and fill joints and cracks in substrate in accordance with waterproofing manufacturer's written instructions and to recommendations in ASTM C898/C898M and ASTM C1471/C1471M. Before coating surfaces, remove dust and dirt from joints and cracks in accordance with ASTM D4258.
 - 1. Comply with ASTM C1193 for joint-sealant installation.
 - 2. Apply bond breaker on sealant surface, beneath preparation strip.
 - 3. Prime substrate along each side of joint and apply a single thickness of preparation strip at least **6 inches (150 mm)** wide along each side of joint. Apply waterproofing in two separate applications and embed a joint reinforcing strip in the first preparation coat.
- B. Install sheet flashing and bond to deck and wall substrates where required in accordance with waterproofing manufacturer's written instructions.

1. Extend sheet flashings for **4 inches (100 mm)** onto perpendicular surfaces and items penetrating substrate.

3.5 INSTALLATION OF WATERPROOFING

- A. Apply waterproofing in accordance with manufacturer's written instructions and to recommendations in ASTM C898/C898M and ASTM C1471/C1471M.
- B. Start installing waterproofing in presence of manufacturer's technical representative.
- C. Apply primer over prepared substrate unless otherwise instructed in writing by waterproofing manufacturer.
- D. Unreinforced Waterproofing Applications: Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.
 1. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases and pinholes, with a dry film thickness of **60 mils (1.5 mm)**.
 2. Apply waterproofing to prepared wall terminations and vertical surfaces.
 3. Verify manufacturer's recommended wet film thickness of waterproofing every **100 sq. ft. (9.3 sq. m)**.
- E. Cure waterproofing, taking care to prevent contamination and damage during application and curing.
- F. Install protection course with butted joints over waterproofing before starting subsequent construction operations.
 1. For horizontal applications, install protection course loose laid over fully cured membrane.
 2. For vertical applications, set protection course in nominally cured membrane, which will act as an adhesive. If membrane cures before application of protection course, use adhesive.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage asite representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components and to furnish daily reports to Architect.
- B. Waterproofing will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.7 PROTECTION

- A. Do not permit foot or vehicular traffic on unprotected membrane.

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- B. Protect waterproofing from damage and wear during remainder of construction period.
- C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

END OF SECTION 071416

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board insulation.
2. Polyisocyanurate foam-plastic board insulation.
3. Glass-fiber blanket insulation.
4. Loose-fill insulation.

B. Related Requirements:

1. Section 042000 "Unit Masonry" for insulation installed in masonry cells.
2. Section 071326 "Self-Adhering Sheet Waterproofing" for insulated drainage panels installed with plaza deck insulation.
3. Section 072119 "Foamed-in-Place Insulation" for spray-applied polyurethane foam insulation.
4. Section 075423 "Thermoplastic-Polyolefin (TPO) Roofing" for insulation specified as part of roofing construction.
5. Section 092900 "Gypsum Board" for sound attenuation blanket used as acoustic insulation.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Extruded polystyrene foam-plastic board insulation.
2. Polyisocyanurate foam-plastic board insulation.
3. Glass-fiber blanket insulation.

B. Sustainable Design Submittals:

1. [Product Data](#): For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. [Environmental Product Declaration](#): For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. [Product Data](#): For adhesives, indicating VOC content.
6. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
7. [Laboratory Test Reports](#): For insulation, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

- A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.
 - 1. Sign, date, and post the certification in a conspicuous location on Project site.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Research Reports: For foam-plastic insulation, from ICC-ES.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
 - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
 - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes less than 25 and 450 when tested in accordance with ASTM E84.
- B. Fire-Resistance Ratings: Comply with ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.
- C. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
- D. Labeling: Provide identification of mark indicating R-value of each piece of insulation **12 inches (305 mm)** and wider in width.
- E. Thermal-Resistance Value (R-Value): R-value as indicated on Drawings in accordance with ASTM C518.

- F. Verify insulation complies with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - 1. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION (INS-1)

- A. Extruded Polystyrene Board Insulation, Type IV: ASTM C578, Type IV, **25-psi (173-kPa)** minimum compressive strength; unfaced.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. DiversiFoam Products.
 - b. DuPont de Nemours, Inc.
 - c. Owens Corning.
 - d. The Dow Chemical Company.

2.3 FOAMED-IN-PLACE SHEATHING INSULATION (INS-2)

- A. Refer to Section -072119 Foamed-in-place Insulation

2.4 FOAMED-IN-PLACE framed wall cavity INSULATION (INS-3)

- A. Refer to Section -072119 Foamed-in-place Insulation

2.5 GLASS-FIBER BLANKET INSULATION (INS-4)

- A. Glass-Fiber Blanket Insulation, Unfaced: ASTM C665, Type I; passing ASTM E136 for combustion characteristics.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Certainteed; SAINT-GOBAIN.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Owens Corning.

2.6 INSULATION FASTENERS

- A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
 - 1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square.
 - 2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation.
 - 3. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
 - a. Ceiling plenums.
 - b. Attic spaces.
- B. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

2.7 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
 - 1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
 - 2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Install insulation with manufacturer's R-value label exposed after insulation is installed.

- D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF SLAB INSULATION

- A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
 - 1. If not otherwise indicated, extend insulation a minimum of **24 inches (610 mm)** below exterior grade line.

3.4 INSTALLATION OF FOUNDATION WALL INSULATION

- A. Butt panels together for tight fit.
- B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
 - 1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions.
 - 2. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.
 - 3. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.
- C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.5 INSTALLATION OF CAVITY-WALL INSULATION

- A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately **24 inches (610 mm)** o.c. both ways on inside face and as recommended by manufacturer.
 - 1. Fit courses of insulation between[**wall ties and other**] obstructions, with edges butted tightly in both directions, and with faces flush.
 - 2. Press units firmly against inside substrates.
 - 3. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 042000 "Unit Masonry."

3.6 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 - 3. Maintain **3-inch (76-mm)** clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 - 4. For metal-framed wall cavities where cavity heights exceed **96 inches (2438 mm)**, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
 - 1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately **2.5 lb/cu. ft. (40 kg/cu. m)**.
 - 2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.7 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

- B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 072119 - FOAMED-IN-PLACE INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Closed-cell spray polyurethane foam insulation.
2. Accessories.

B. Related Requirements:

1. Section 072100 "Thermal Insulation" for foam-plastic board insulation.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Closed-cell spray polyurethane foam insulation.
2. Accessories.

B. Sustainable Design Submittals:

1. **Product Data:** For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. **Environmental Product Declaration:** For each product.
3. **Health Product Declaration:** For each product.
4. **Sourcing of Raw Materials:** Corporate sustainability report for each manufacturer.
5. **Product Data:** For adhesives, indicating VOC content.
6. **Laboratory Test Reports:** For adhesives, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by qualified testing agency.

B. Research Reports: For spray-applied polyurethane foam-plastic insulation, from ICC-ES showing compliance with IBC/IECC requirements.

C. Qualification Statements: For Installer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 CLOSED-CELL SPRAY POLYURETHANE FOAM INSULATION

- A. Closed-Cell Spray Polyurethane Foam: ASTM C1029, Type II, minimum density of 1.5 lb/cu. ft. (24 kg/cu. m) and minimum aged R-value at 1-inch (25.4-mm) thickness of 6.2 deg F x h x sq. ft./Btu at 75 deg F (43 K x sq. m/W at 24 deg C).
 - 1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 - 2. Fire Propagation Characteristics: Passes NFPA 285 and NFPA 276 testing as part of an approved assembly.

2.2 ACCESSORIES

- A. Primer: Material recommended by insulation manufacturer where required for adhesion of insulation to substrates.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that substrates are clean, dry, and free of substances that are harmful to insulation.
- B. Priming: Prime substrates where recommended by insulation manufacturer. Apply primer to comply with insulation manufacturer's written instructions. Confine primers to areas to be insulated; do not allow spillage or migration onto adjoining surfaces.

3.2 INSTALLATION

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Spray insulation to envelop entire area to be insulated and fill voids.
- C. Apply in multiple passes to not exceed maximum thicknesses recommended by manufacturer. Do not spray into rising foam.

- D. Framed Construction: Install into cavities formed by framing members to achieve thickness indicated on Drawings.
- E. Cavity Walls: Install into cavities to thickness indicated on Drawings.
- F. Miscellaneous Voids: Apply according to manufacturer's written instructions.
- G. Install thermal barrier material.
 - 1. Do not cover insulation prior to any required spray foam insulation inspections.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect spray foam insulation installation, including accessories. Report results in writing.

3.4 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

END OF SECTION 072119

SECTION 072726 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. High-build air barriers, vapor retarding.

B. Related Requirements:

1. Section 061600 "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.

1.2 DEFINITIONS

A. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.

B. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

C. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.

1.3 ACTION SUBMITTALS

A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating each substrate; technical data; dry film thickness; and tested physical and performance properties of products.

1. High-build air barriers, vapor retarding.

B. Shop Drawings: For air-barrier assemblies.

1. Show locations and extent of air-barrier materials, accessories, and assemblies specific to Project conditions.
2. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
3. Include details of interfaces with other materials that form part of air barrier.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

- B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.
- C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
 - 1. Installer to be licensed by ABAA in accordance with ABAA's Quality Assurance Program and to employ ABAA-certified installers and supervisors on Project.
- B. Mockups: Build mockups to set quality standards for materials and execution.
 - 1. Build integrated mockups of exterior wall assembly, 150 sq. ft. (14 sq. m), incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- B. Protect stored materials from direct sunlight.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended in writing by air-barrier manufacturer.
 - 1. Protect substrates from environmental conditions that affect air-barrier performance.
 - 2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain primary air-barrier materials and air-barrier accessories from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction to be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Air-Barrier Assembly Air Leakage: Maximum **0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft.** (**0.2 L/s x sq. m of surface area at 75 Pa**), when tested in accordance with ASTM E2357.
- C. Air Permeance: Maximum **0.004 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft.** (**0.02 L/s x sq. m of surface area at 75 Pa**) pressure difference; ASTM E2178.
- D. Ultimate Elongation: Minimum 250 percent; ASTM D412, Die C.
- E. Adhesion to Substrate: Minimum **16 lbf/sq. in. (110 kPa)** when tested in accordance with ASTM D4541.
- F. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
- G. UV Resistance: Can be exposed to sunlight for 90 days in accordance with manufacturer's written instructions.

2.3 HIGH-BUILD AIR BARRIERS, VAPOR RETARDING

- A. High-Build, Vapor-Retarding Air Barrier, Synthetic Polymer Type: Synthetic polymer membrane with an installed dry film thickness, according to manufacturer's written instructions, of **35 mils (0.9 mm)** or thicker over smooth, void-free substrates.
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Carlisle Coatings & Waterproofing Inc.](#)
 - b. [Henry Company.](#)
 - c. [Hohmann & Barnard, Inc.](#)
 - d. [Sto Corp.](#)
 - e. [W. R. Meadows, Inc.](#)

- B. Vapor Permeance: Maximum 0.1 perm (5.8 ng/Pa x s x sq. m); ASTM E96/E96M, Procedure A, Desiccant Method.

2.4 ACCESSORY MATERIALS

- A. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.
- B. Primer: Liquid waterborne primer recommended for substrate by air-barrier material manufacturer.
- C. Stainless Steel Sheet: ASTM A240/A240M, Type 304, 0.0187 inch (0.5 mm) thick, and Series 300 stainless steel fasteners.
- D. Preformed Silicone Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding extrusions to substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
 - 2. Verify that substrates have cured and aged for minimum time recommended in writing by air-barrier manufacturer.
 - 3. Verify that substrates are visibly dry and free of moisture.
 - 4. Verify that masonry joints are flush and completely filled with mortar.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate in accordance with manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching material.
- E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.
- H. Bridge isolation joints and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement in accordance with manufacturer's written instructions and details.

3.3 INSTALLATION OF ACCESSORIES

- A. Install accessory materials in accordance with air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.
 - 1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 - 2. Install transition strip on roofing membrane or base flashing so that a minimum of **3 inches (75 mm)** of coverage is achieved over each substrate.
 - 3. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
 - 4. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
- B. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- C. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.
- D. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- E. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip so that a minimum of **3 inches (75 mm)** of

coverage is achieved over each substrate. Maintain **3 inches (75 mm)** of full contact over firm bearing to perimeter frames, with not less than **1 inch (25 mm)** of full contact.

1. Transition Strip: Roll firmly to enhance adhesion.
 2. Preformed Silicone Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.
- F. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.
- G. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.
- H. Seal top of through-wall flashings to air barrier with an additional **6-inch- (150-mm-)** wide, transition strip.
- I. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- J. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending **6 inches (150 mm)** beyond repaired areas in strip direction.

3.4 INSTALLATION OF PRIMARY AIR-BARRIER MATERIAL

- A. Apply air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier in accordance with air-barrier manufacturer's written instructions and details. Apply air-barrier material within manufacturer's recommended application temperature ranges.
1. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
 2. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
 3. Where multiple prime coats are needed to achieve required bond, allow adequate drying time between coats.
- B. High-Build Air Barriers: Apply continuous unbroken air-barrier material to substrates according to the following thickness. Apply air-barrier material in full contact around protrusions such as masonry ties.
1. Vapor-Retarding, High-Build Air Barrier: Total dry film thickness as recommended in writing by manufacturer to comply with performance requirements, but not less than **35 mils (0.9 mm)**, applied in one or more equal coats.
- C. Do not cover air barrier until it has been tested and inspected by testing agency.
- D. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
 - 1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
 - 2. Air-barrier dry film thickness.
 - 3. Continuous structural support of air-barrier system has been provided.
 - 4. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
 - 5. Site conditions for application temperature and dryness of substrates have been maintained.
 - 6. Maximum exposure time of materials to UV deterioration has not been exceeded.
 - 7. Surfaces have been primed, if applicable.
 - 8. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
 - 9. Termination mastic has been applied on cut edges.
 - 10. Strips and transition strips have been firmly adhered to substrate.
 - 11. Compatible materials have been used.
 - 12. Transitions at changes in direction and structural support at gaps have been provided.
 - 13. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
 - 14. All penetrations have been sealed.
- C. Air barriers will be considered defective if they do not pass tests and inspections.
 - 1. Apply additional air-barrier material, in accordance with manufacturer's written instructions, where inspection results indicate insufficient thickness.
 - 2. Remove and replace deficient air-barrier components for retesting as specified above.
- D. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
- E. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, in accordance with manufacturer's written instructions.
 - 1. Protect air barrier from exposure to UV light and harmful weather exposure as recommended in writing by manufacturer. If exposed to these conditions for longer than recommended, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed materials in accordance with air-barrier manufacturer's written instructions.

2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended in writing by manufacturer of affected construction.
 - C. Remove masking materials after installation.

END OF SECTION 072726

SECTION 074213.23 - METAL COMPOSITE MATERIAL WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Metal composite material (MCM) system.

1.2 DEFINITIONS

- A. DBVC: Drained and back-ventilated cavity rainscreen system designed to drain and dry water entering cavity through drainage channels, weeps, and air ventilation.
- B. MCM: Metal composite material; cladding material formed by joining two thin metal skins to polyethylene or fire-retardant core and bonded under precise temperature, pressure, and tension.
- C. PER: Pressure-equalized rainscreen system designed for no water intrusion, with equal pressure within air cavity and outside cladding barrier.

1.3 ACTION SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel, system, and accessory.
1. Metal composite material (MCM) system.
- B. Shop Drawings:
1. Include fabrication and installation layouts of MCM system; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, accessories, and special details.
 2. Accessories: Include details of flashing, trim, and anchorage, at a scale of not less than **1-1/2 inches per 12 inches (1:10)**.
 3. Provide signed and sealed drawings, by a qualified design professional in Project jurisdiction, of MCM system showing compliance with performance requirements and design criteria identified for this Project.
- C. Samples for Initial Selection: For each type of MCM panel indicated, with factory-applied color finishes.
1. Size: Manufacturers' standard size.
 2. Include Samples of trim and accessories involving color selection.
- D. Samples for Verification: For each type of MCM panel required, with factory-applied color finishes.

1. MCM Panel: Two samples, Manufacturers' standard size.
- E. Delegated Design Submittals: For MCM system, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- F. Sustainable Design Submittals:
 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 2. Environmental Product Declaration: For each product.
 3. Health Product Declaration: For each product.
 4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.4 INFORMATIONAL SUBMITTALS

- A. Test and Evaluation Reports:
 1. Product Test Reports: For each MCM panel, for tests performed by qualified testing agency.
 - a. MCM Panel Manufacturer's Material Test Reports: Certified test reports showing compliance with specific performance or third-party listing documenting compliance in accordance with the IBC.
 - b. Fabricator's MCM System Test Reports: Certified test reports showing system compliance with specific performance or third-party listing documenting compliance in accordance with the IBC.
 - 1) Dry or Wet Seal System: Tested to AAMA 501.1.
 2. Research Reports: For MCM systems, from ICC-ES showing compliance with.
- B. Qualification Statements: For Installer.
- C. Delegated design engineer qualifications.
- D. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For MCM panels.
- B. Warranty Documentation:
 1. Manufacturers' special warranties.
 2. Installer's special warranties.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum 5 years' experience.
- B. Fabricator Qualifications: Approved by MCM panel manufacturer.
- C. Installer Qualifications: Entity that employs installers and supervisors who are trained and approved by MCM system manufacturer.
- D. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of the type indicated.
- E. Testing Agency Qualifications: An agency acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, MCM panels, and other manufactured items so as not to be damaged or deformed. Package MCM panels for protection during transportation and handling.
- B. Unload, store, and erect MCM panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack MCM panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store MCM panels to ensure dryness, with positive slope for drainage of water. Do not store MCM panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on MCM panels during installation.
- E. Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.8 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of MCM panels to be performed in accordance with manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

- A. Coordinate MCM panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

- A. Panel Integrity Warranty: Manufacturer agrees to repair or replace components of MCM panels that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 2. Warranty Period: 10 years from date of Substantial Completion.
- B. Panel Finish Warranty: Manufacturer agrees to repair finish or replace MCM panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: 20 years from date of Substantial Completion.
- C. MCM System Warranty: System manufacturer's standard form in which manufacturer agrees to repair or replace components of MCM systems that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design MCM system.
- B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 70 percent.
- C. Structural Performance: MCM systems to withstand the effects of the following loads, based on testing in accordance with ASTM E330/E330M:
 1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: As indicated on Drawings.
 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- D. Air Infiltration: Air leakage of not more than **0.06 cfm/sq. ft. (0.3 L/s per sq. m)** when tested in accordance with ASTM E283/E283M at the following test-pressure difference:
 1. Test-Pressure Difference: **1.57 lbf/sq. ft. (75 Pa)**.

- E. Water Penetration under Static Pressure: No water penetration when tested in accordance with ASTM E331 at the following test-pressure difference:
 - 1. Test-Pressure Difference: **2.86 lbf/sq. ft. (137 Pa)**.
- F. Water Penetration under Dynamic Pressure: No water penetration when tested in accordance with AAMA 501.1 at the following test pressure:
 - 1. Test Pressure: **6.24 psf (300 Pa)**.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: **120 deg F (67 deg C)**, ambient; **180 deg F (100 deg C)**, material surfaces.
- H. Fire Propagation Characteristics: MCM system passes NFPA 285 testing.

2.2 METAL COMPOSITE MATERIAL (MCM) WALL PANELS

- A. Metal Composite Material (MCM) Wall Panels: Provide MCM panels fabricated from two metal facings bonded to a solid, extruded thermoplastic core.
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. **ALUCOBOND; 3A Composites USA, Inc.**
 - b. **Arconic.**
 - c. **VM Building Solutions USA.**
 - 2. Core: FR.
 - 3. Panel Thickness: **0.157 inch (4 mm)**.
 - 4. Bond Strength: **22.5 in-lb/in. (100 N x mm/mm)** when tested for bond integrity in accordance with ASTM D1781.
 - 5. Fire Performance: Flame-spread index less than **[25] [75]** and smoke-developed index less than 450, in accordance with ASTM E84 or UL 723.
- B. MCM Panel Materials:
 - 1. Aluminum-Faced Panels: ASTM B209/B209M alloy as standard with manufacturer, temper as required to suit finish and forming operations with **0.020-inch- (0.50-mm-)** thick, aluminum sheet facings.
 - a. Exterior Finish: Two-coat fluoropolymer.
 - 1) Color: As selected by Architect from manufacturer's full range.

2.3 METAL COMPOSITE MATERIAL (MCM) SYSTEM

- A. DBVC MCM System: Provide factory-formed and -assembled, MCM panels formed into profile for DBVC system installation, drained at horizontal joints and at base of wall. Include attachment assembly components, and accessories required for weathertight system.
- B. System Panel Depth: 1-3/4 inches (44 mm).
- C. Attachment Assembly Components: Manufacturer's standard formed from material compatible with panel facing.
- D. Labeling: Comply with labeling requirement of applicable building code.

2.4 ACCESSORIES

- A. Metal Subframing and Furring: ASTM C955 cold-formed, metallic-coated steel sheet ASTM A653/A653M, G90 (Z275) hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 (Class AZM150) aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of MCM system.
- B. System Accessories: Provide components required for a complete, weathertight wall system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of MCM panels unless otherwise indicated.
- C. Flashing and Trim: Provide flashing and trim formed from same material as MCM panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent MCM panels.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Use gasketed or approved coated fasteners between dissimilar metals.
 - 1. Aluminum Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
- E. Panel Sealants: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in MCM panels and remain weathertight; and as recommended in writing by MCM system manufacturer.

2.5 FABRICATION

- A. Fabricate and finish MCM panels at the factory, by panel manufacturer's standard procedures and processes, as necessary to fulfill indicated panel performance requirements demonstrated by laboratory testing.

- B. Shop-fabricate MCM systems and accessories by fabricator's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with requirements of MCM panel manufacturer, of indicated system profiles, and with dimensional and structural requirements.
1. Fabricate panels to dimensions indicated on Drawings based on an assumed design temperature of 70 deg F (21 deg C). Allow for ambient temperature range at time of fabrication.
 2. Formed MCM panel lines, breaks, and angles to be sharp and straight, with surfaces free from warp or buckle.
 3. Fabricate panels with sharply cut edges and no displacement of face sheet or protrusion of core.
 4. Fabricated Panel Tolerances: Shop-fabricate panels to sizes and joint configurations indicated on Drawings.
 - a. Width: Plus or minus 0.079 inch (2 mm) at 70 deg F (21 deg C).
 - b. Length: Plus or minus 0.079 inch (2 mm) at 70 deg F (21 deg C).
 - c. Squareness: Plus or minus 0.079 inch (2 mm) at 70 deg F (21 deg C).
 5. Fabricate MCM panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
 6. Attach routed-and-returned panel flanges to panel clips with manufacturer's standard fasteners.
- C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's written instructions and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams.
 4. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Coil-Coated Metal Finish:
 - 1. PVDF Fluoropolymer: AAMA 2605, two-coat fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat[**and clear topcoat**]. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, MCM system supports, and other conditions affecting performance of the Work.
 - 1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by MCM system manufacturer.
 - 2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by MCM system manufacturer.
 - a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and assemblies penetrating MCM system to verify actual locations of penetrations relative to seam locations of MCM panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF MCM SYSTEM

- A. General: Install MCM system in accordance with system manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to supports unless otherwise indicated. Anchor MCM system securely in place, with provisions for thermal and structural movement.
 - 1. Shim or otherwise plumb substrates receiving MCM system.

2. Flash and seal MCM system at perimeter of all openings. Fasten with self-tapping screws.
 3. Install screw fasteners in predrilled holes.
 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 5. Install flashing and trim as MCM system work proceeds.
 6. Align bottoms of MCM panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 7. Provide weathertight escutcheons for all items penetrating system.
 8. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by MCM system manufacturer.
 9. Attach MCM panels to supports at locations, spacings, and with fasteners recommended by manufacturer to meet listed performance requirements.
- B. Attachment Assembly, General: Install attachment assembly required to support MCM panels and to provide a complete weathertight wall system, including tracks, drainage channels, anchor channels, perimeter extrusions, and panel clips.
1. Install subframing, furring, and other panel support members and anchorages in accordance with ASTM C955.
 2. Install support system at locations, at spacings, and with fasteners recommended by MCM system manufacturer to meet listed performance requirements.
- C. DBVC MCM System: Install vertical tracks and horizontal tracks at locations, at spacings, and with fasteners recommended by system manufacturer.
1. Attach MCM panels by interlocking panel clips into tracks.
 2. Insert matching MCM spline into tracks at joint reveal locations.
- D. Install panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.
- E. Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install accessory components required for a complete MCM system assembly including trim, copings, corners, seam covers, flashings, sealants gaskets, fillers, closure strips, and similar items. Provide types indicated by MCM system manufacturer.
- F. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
1. Install exposed flashing and trim that is without buckling and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install trim to fit substrates and to result in waterproof performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 ft. (3 m) with no joints allowed within 24 inches (605 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked

flanges, not less than **1 inch (25 mm)** deep, filled with mastic sealant (concealed within joints).

3.3 INSTALLATION TOLERANCES

- A. Shim and align MCM panels within installed tolerance of **1/4 inch in 20 ft. (6 mm in 6 m)**, non-accumulative, on level, plumb, and location lines as indicated, and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed MCM system installation, including accessories.
- B. MCM system will be considered defective if it does not pass test and inspections.
- C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- D. Prepare test and inspection reports.

3.5 CLEANING

- A. Remove temporary protective coverings and strippable films as MCM panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, clean finished surfaces as recommended by MCM panel manufacturer. Maintain in a clean condition during construction.
- B. After installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

3.6 PROTECTION

- A. Replace MCM panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074213.23

SECTION 074293 - SOFFIT PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal soffit panels.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Metal soffit panels.

B. Product Data Submittals:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

C. Sustainable Design Submittals:

1. **Product Data:** For recycled content, indicating postconsumer and preconsumer recycled content and cost.

D. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of flashing, trim, and anchorage systems, at a scale of not less than **1-1/2 inches per 12 inches (1:10)**.

E. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

F. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Metal Panels: **12 inches (305 mm)** long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, tests performed by a qualified testing agency.
- C. Sample Warranties: For special warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.
- E. Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.7 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.8 COORDINATION

- A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. **Recycled Content:** Postconsumer recycled content plus one-half of preconsumer recycled content not less than 75 percent.
- B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings.
 - 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- C. Air Infiltration: Air leakage of not more than **0.06 cfm/sq. ft. (0.3 L/s per sq. m)** when tested according to ASTM E283 at the following test-pressure difference:
 - 1. Test-Pressure Difference: **1.57 lbf/sq. ft. (75 Pa)**.
- D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:
 - 1. Test-Pressure Difference: **2.86 lbf/sq. ft. (137 Pa)**.

- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METAL SOFFIT PANELS

- A. Provide metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.
- B. Metal Soffit Panels: Match MCM wall panels.
 - 1. Finish: Match finish and color of metal wall panels.
 - 2. Sealant: Factory applied within interlocking joint.
- C. Flush-Profile Metal Soffit Panels: Solid panels formed with vertical panel edges and a flat pan between panel edges; with flush joint between panels.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. AEP Span a brand of ASC Profiles LLC, a part of BlueScope.
 - b. ATAS International, Inc.
 - c. Berridge Manufacturing Company.
 - d. CENTRIA, a Nucor Brand.
 - e. MBCI; Cornerstone Building Brands.
 - f. McElroy Metal, Inc.
 - g. Merchant & Evans Inc.
 - h. PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company.
 - 2. Material: Same material, finish, and color as metal wall panels.
 - 3. Aluminum Sheet: Coil-coated sheet, **ASTM B209 (ASTM B209M)**, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
 - a. Thickness: 0.032 inch (0.81 mm).
 - b. Surface: Smooth, flat finish.
 - c. Exterior Finish: Two-coat fluoropolymer.
 - d. Color: Match Architect's samples <Insert color>.

2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, **G90 (Z275)** hot-dip galvanized coating designation or ASTM A792/A792M, **Class AZ50 (Class AZM150)** aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 - 1. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum **1-inch- (25-mm-)** thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
- E. Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape **1/2 inch (13 mm)** wide and **1/8 inch (3 mm)** thick.
 - 2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
 - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.4 FABRICATION

- A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

- D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal soffit panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Aluminum Panels and Accessories:
1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 - 1. Examine framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal panel manufacturer.
 - 2. Examine sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal panel manufacturer.
 - a. Verify that air- or water-resistive barriers been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.
 - 1. Soffit Framing: Wire tie or clip furring channels to supports.

3.3 INSTALLATION OF METAL SOFFIT PANELS

- A. Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Shim or otherwise plumb substrates receiving metal panels.
 - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
 - 3. Install screw fasteners in predrilled holes.
 - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 5. Install flashing and trim as metal panel work proceeds.
 - 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 - 7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

- B. Fasteners:
 - 1. Aluminum Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- D. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
 - 1. Apply panels and associated items true to line for neat and weathertight enclosure.
 - 2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
 - 3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
 - 4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
- E. Watertight Installation:
 - 1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels and elsewhere as needed to make panels watertight.
 - 2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 - 3. At panel splices, nest panels with minimum **6-inch (152-mm)** end lap, sealed with sealant and fastened together by interlocking clamping plates.
- F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for a complete metal panel system including trim, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.
- G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
 - 1. Install exposed flashing and trim that is without buckling, and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
 - 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of **10 feet (3 m)** with no joints allowed within **24 inches (610 mm)** of corner or intersection. Where lapped expansion provisions cannot be used or

would not be waterproof, form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with mastic sealant (concealed within joints).

3.4 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074293

SECTION 075423 - THERMOPLASTIC-POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoplastic polyolefin (TPO) roofing system.
2. Accessory roofing materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation.
6. Insulation accessories and cover board.
7. Walkways.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 072100 "Thermal Insulation" for insulation beneath the roof deck.
3. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
4. Section 077100 "Roof Specialties" for manufactured copings and roof edge flashings.
5. Section 077129 "Manufactured Roof Expansion Joints" for manufactured roof expansion-joint assemblies.
6. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.2 DEFINITIONS

- ##### A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

1.4 ACTION SUBMITTALS

A. Product Data:

1. Thermoplastic polyolefin (TPO) roofing system.
2. Accessory roofing materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation.
6. Insulation accessories and cover board.

7. Asphalt materials.
8. Walkways.
9. For insulation and roof system component fasteners, include copy of FM Approvals' RoofNav listing.

B. Sustainable Design Submittals:

1. **Product Test Reports:** For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. **Product Data:** For recycled content, indicating postconsumer and preconsumer recycled content and cost.
3. **Environmental Product Declaration:** For each product.
4. **Health Product Declaration:** For each product.
5. **Sourcing of Raw Materials:** Corporate sustainability report for each manufacturer.

C. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane termination details.
3. Flashing details at penetrations.
4. Tapered insulation layout, thickness, and slopes.
5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Tie-in with adjoining air barrier.

D. Samples for Verification: For the following products:

1. Roof membrane and flashings, of color required.
2. Walkway pads or rolls, of color required.

E. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Manufacturer Certificates:

1. **Performance Requirement Certificate:** Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - a. Submit evidence of compliance with performance requirements.
2. **Special Warranty Certificate:** Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

- C. Product Test Reports: For roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.
- D. Evaluation Reports: For components of roofing system, from ICC-ES.
- E. Field quality-control reports.
- F. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing system to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is listed in FM Approvals' RoofNav for roofing system identical to that used for this Project.
- B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
 - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
 - 1. Special warranty includes roof membrane, base flashings, roof insulation, fasteners, cover boards, vapor retarder, substrate board, and other components of roofing system.
 - 2. Warranty Period: 30 years from date of Substantial Completion.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, and walkway products, for the following warranty period:
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings to remain watertight.
 - 1. Accelerated Weathering: Roof to withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
 - 2. Impact Resistance: Roof membrane to resist impact damage when tested according to ASTM D3746, ASTM D4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.
- B. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.
- C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897:
 - 1. Zone 1 (Roof Area Field): 44 lbf/sq. ft. (kPa).
 - 2. Zone 2 (Roof Area Perimeter): 57 lbf/sq. ft. (kPa).
 - a. Location: From roof edge to 17 feet inside roof edge.
 - 3. Zone 3 (Roof Area Corners): 57 lbf/sq. ft. (kPa).
 - a. Location: 17 feet in each direction from each building corner.

- D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.
 - 1. Fire/Windstorm Classification: Class 1A-105.
 - 2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 SH.
- E. SPRI's Directory of Roof Assemblies Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in SPRI's Directory of Roof Assemblies for roof assembly identical for that specified for this Project.
 - 1. Wind Uplift Load Capacity: 105 psf.
- F. [Solar Reflectance Index \(SRI\)](#): Three-year-aged SRI not less than 64 or initial SRI not less than 82 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- G. Energy Star Listing: Roofing system to be listed on the DOE's Energy Star "Roof Products Qualified Product List" for low-slope roof products.
- H. Energy Performance: Roofing system to have an initial solar reflectance of not less than 0.70 and an emissivity of not less than 0.75 when tested in accordance with ANSI/CRRC S100.
- I. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- J. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

2.2 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING SYSTEM

- A. TPO Sheet: ASTM D6878/D6878M, internally fabric- or scrim-reinforced, self-adhering TPO sheet.
 - 1. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Carlisle Syntec Systems](#).
 - b. [Firestone Building Products](#).
 - c. [GAF](#).
 - d. [Johns Manville; a Berkshire Hathaway company](#).
 - e. [Versico Roofing Systems; Carlisle Construction Materials](#).
 - 2. Source Limitations: Obtain components for roofing system from roof membrane manufacturer or manufacturers approved by roof membrane manufacturer.

3. Thickness: **60 mils (1.5 mm)**, nominal.
4. Exposed Face Color: White.
5. **Recycled Content**: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 10 percent.

2.3 ACCESSORY ROOFING MATERIALS

- A. General: Accessory materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
 1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
 2. **Verify adhesives and sealants comply** with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, **55 mils (1.4 mm)** thick, minimum, of same color as TPO sheet.
- C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- D. Roof Vents: As recommended by roof membrane manufacturer.
 1. Size: Not less than **4-inch (100-mm)** diameter.
- E. Bonding Adhesive: Manufacturer's standard.
- F. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately **1 by 1/8 inch (25 by 3 mm)** thick; with anchors.
- G. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.
- H. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.4 SUBSTRATE BOARD

- A. Gypsum Board Type X: ASTM C1396/C1396M.
 1. Thickness: **5/8 inch (16 mm)**.
- B. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Certainteed; SAINT-GOBAIN.](#)
 - b. [Georgia-Pacific Gypsum LLC.](#)
 - c. Gold Bond Building Products, LLC provided by National Gypsum Company.
 - d. [USG Corporation.](#)
 2. Thickness: **1/4 inch (6 mm)** thick.
 3. Surface Finish: Factory primed.
- C. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.5 VAPOR RETARDER (at concrete deck only)

- A. Laminated Sheet Vapor Retarder: Two-layer, fire-retardant polyethylene laminate, reinforced with cord grid.
1. Permeance Rating: Not more than **0.062 perm (3.556 ng/Pa x s x sq. m)** when tested in accordance with ASTM E96/E96M.
 2. Flame-Spread Index: Not more than 5 when tested in accordance with ASTM E84.
 3. Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.
 4. Tape: Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.6 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by TPO roof membrane manufacturer, approved for use in FM Approvals' RoofNav listed roof assemblies.
- B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Atlas Polyiso Roof and Wall Insulation.](#)
 - b. [Carlisle Syntec Systems.](#)
 - c. [Certainteed; SAINT-GOBAIN.](#)
 - d. [Firestone Building Products.](#)
 - e. [GAF.](#)
 - f. [Insulfoam; Carlisle Construction Materials Company.](#)
 - g. [Johns Manville; a Berkshire Hathaway company.](#)
 - h. [Rmax, Inc.](#)

2. Compressive Strength: **20 psi (138 kPa)**.
3. Size: **48 by 48 inches (1219 by 1219 mm)**.
4. Thickness (nominal, subject to overall baseline minimum R-30 performance):
 - a. Base Layer: **2-1/2 inches**.
 - b. Upper Layer: 2-1/2 inches.

C. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: Match roof insulation.
2. Minimum Thickness: **1/4 inch (6.35 mm)**.
3. Slope:
 - a. Saddles and Crickets: **1/2 inch per foot (1:24)** unless otherwise indicated on Drawings.

2.7 INSULATION ACCESSORIES AND COVER BOARD

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.
- B. Fasteners: Factory-coated steel fasteners with metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 1. Full-spread, spray-applied, low-rise, two-component urethane adhesive.
 2. Verify adhesives and sealants comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Certainteed; SAINT-GOBAIN.
 - b. Georgia-Pacific Gypsum LLC.
 - c. Gold Bond Building Products, LLC provided by National Gypsum Company.
 - d. USG Corporation.
 2. Thickness: **1/4 inch (6 mm)**.
 3. Surface Finish: Factory primed.

2.8 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately **3/16 inch (5 mm)** thick and acceptable to roofing system manufacturer.
 - 1. Size: Approximately **36 by 60 inches (914 by 1524 mm)**.
 - 2. Color: Contrasting with roof membrane.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
 - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 - 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
 - 4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
 - 5. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than 75 percent, or as recommended by roofing system manufacturer, when tested according to ASTM F2170.
 - a. Test Frequency: One test probe per each **1000 sq. ft. (93 sq. m)**, or portion thereof, of roof deck, with not less than three tests probes.
 - b. Submit test reports within 24 hours after performing tests.
 - 6. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
 - 7. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation according to roofing system manufacturer's written instructions. Remove sharp projections.

- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Perform fastener-pullout tests according to roof system manufacturer's written instructions.
 - 1. Submit test result within 24 hours after performing tests.
 - a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

3.3 INSTALLATION OF ROOFING, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions, FM Approvals' RoofNav listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning Work on adjoining roofing.
- C. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under Section 072726 "Fluid-Applied Membrane Air Barriers."

3.4 INSTALLATION OF SUBSTRATE BOARD

- A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches (610 mm)** in adjacent rows.
 - 1. At steel roof decks, install substrate board at right angle to flutes of deck.
 - a. Locate end joints over crests of steel roof deck.
 - 2. Tightly butt substrate boards together.
 - 3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - 4. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29.
 - 5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.

3.5 INSTALLATION OF VAPOR RETARDER

- A. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of **3-1/2 and 6 inches (90 and 150 mm)**, respectively.
 - 1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
 - 2. Seal laps by rolling.
- B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF INSULATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and roof insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Metal Decking:
 - 1. Install base layer of insulation with joints staggered not less than **24 inches (610 mm)** in adjacent rows, end joints staggered not less than **12 inches (305 mm)** in adjacent rows, and with long joints continuous at right angle to flutes of decking.
 - a. Locate end joints over crests of decking.
 - b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - c. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
 - d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.
 - 1) Trim insulation so that water flow is unrestricted.
 - e. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
 - f. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
 - g. Mechanically attach base layer of insulation and substrate board using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
 - 1) Fasten insulation according to requirements in FM Approvals' RoofNav for specified Windstorm Resistance Classification.
 - 2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than **12 inches (305 mm)** from previous layer of insulation.
 - a. Staggered end joints within each layer not less than **24 inches (610 mm)** in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than **12 inches (305 mm)** in adjacent rows.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.
 - 1) Trim insulation so that water flow is unrestricted.
 - f. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
 - g. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
 - h. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - 1) Set each layer of insulation in a uniform coverage of full-spread insulation

D. Installation Over Concrete Decks:

1. Install base layer of insulation with joints staggered not less than **24 inches (610 mm)** in adjacent rows and end joints staggered not less than **12 inches (305 mm)** in adjacent rows.
 - a. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - b. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
 - c. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.
 - 1) Trim insulation so that water flow is unrestricted.
 - d. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
 - e. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
 - f. Adhere base layer of insulation to vapor retarder according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - 1) Prime surface of concrete deck with asphalt primer at rate of **3/4 gal./100 sq. ft. (0.3 L/sq. m)**, and allow primer to dry.

- 2) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than **12 inches (305 mm)** from previous layer of insulation.
 - a. Staggered end joints within each layer not less than **24 inches (305 mm)** in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than **12 inches (305 mm)** in adjacent rows.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.
 - 1) Trim insulation so that water flow is unrestricted.
 - f. Fill gaps exceeding **1/4 inch (6 mm)** with insulation.
 - g. Cut and fit insulation within **1/4 inch (6 mm)** of nailers, projections, and penetrations.
 - h. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - 1) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.7 INSTALLATION OF COVER BOARDS

- A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of **6 inches (150 mm)** in each direction.
 1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 2. At internal roof drains, conform to slope of drain sump.
 - a. Trim cover board so that water flow is unrestricted.
 3. Cut and fit cover board tight to nailers, projections, and penetrations.
 4. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - a. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.8 INSTALLATION OF SELF-ADHERING ROOF MEMBRANE

- A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
- B. Unroll roof membrane and allow to relax before installing.
- C. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
- D. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer.
 - 1. Stagger end laps.
- E. Fold roof membrane to expose half of sheet width's bottom surface.
 - 1. Remove release liner on exposed half of sheet.
 - 2. Roll roof membrane over substrate while avoiding wrinkles.
- F. Fold remaining half of roof membrane to expose bottom surface.
 - 1. Remove release liner on exposed half of sheet.
 - 2. Roll roof membrane over substrate while avoiding wrinkles.
- G. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.
- H. Apply roof membrane with side laps shingled with slope of roof deck where possible.
- I. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings, to ensure a watertight seam installation.
 - 1. Test lap edges with probe to verify seam weld continuity.
 - 2. Apply lap sealant to seal cut edges of roof membrane and flashing sheet.
 - 3. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
 - 4. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.
- J. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.9 INSTALLATION OF BASE FLASHING

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.10 INSTALLATION OF WALKWAYS

A. Flexible Walkways:

- 1. Install flexible walkways at the following locations:
 - a. Retain one or more subparagraphs below. Revise to suit Project.
 - b. Perimeter of each rooftop unit.
 - c. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
 - d. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
 - e. Top and bottom of each roof access ladder.
 - f. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
 - g. Locations indicated on Drawings.
 - h. As required by roof membrane manufacturer's warranty requirements.
- 2. Provide **6-inch (76-mm)** clearance between adjoining pads.
- 3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and to inspect substrate conditions, surface preparation, roof membrane application, sheet flashings, protection, and drainage components, and to furnish reports to Architect.
- B. Perform the following tests:
- C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.
- D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.12 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.13 ROOFING INSTALLER'S WARRANTY

- A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:
 - 1. Owner: Maryland Department of Police
 - 2. Owner Address: <Insert address>.
 - 3. Building Name/Type: <Insert information>.
 - 4. Building Address: <Insert address>.
 - 5. Area of Work: <Insert information>.
 - 6. Acceptance Date: 30 years
 - 7. Expiration Date: _____.
- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.
- D. This Warranty is made subject to the following terms and conditions:
 - 1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
 - a. lightning;
 - b. peak gust wind speed exceeding 90 mph
 - c. fire;
 - d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;

- e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
 - f. vapor condensation on bottom of roofing; and
 - g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
 3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
 4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
 5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
 6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
 7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 075423

SECTION 077100 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copings.
2. Roof-edge specialties.
3. Roof-edge drainage systems.
4. Reglets and counterflashings.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for downspout guards and downspout boots.
2. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
3. Section 077129 "Manufactured Roof Expansion Joints" for manufactured roof expansion-joint cover assemblies.
4. Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
5. Section 079200 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Sustainable Design Submittals:

1. **Product Data:** For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: For roof specialties.

1. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.
2. Include details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
4. Detail termination points and assemblies, including fixed points.
5. Include details of special conditions.

- D. Samples: For each type of roof specialty and for each color and texture specified.
 - 1. Include copings, roof-edge specialties, roof-edge drainage systems, reglets, and counterflashings made from 12-inch (300-mm) lengths of full-size components in specified material, and including fasteners, cover joints, accessories, and attachments.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Product Certificates: For each type of roof specialty.
- C. Product Test Reports: For copings and roof-edge flashings, for tests performed by a qualified testing agency.
- D. Sample Warranty: For manufacturer's special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are FM Approvals listed for specified class.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
- B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.
- B. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.8 WARRANTY

- A. Roofing-System Warranty: Roof specialties are included in warranty provisions in Section 075423 "Thermoplastic-Polyolefin (TPO) Roofing."
- B. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain roof specialties approved by manufacturer providing roofing-system warranty specified in Section 075423 "Thermoplastic-Polyolefin (TPO) Roofing."

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof specialties to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 15 percent.
- C. FM Approvals' Listing: Manufacture and install copings and roof-edge specialties that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-105. Identify materials with FM Approvals' markings.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.3 COPINGS

- A. Metal Copings: Manufactured coping system consisting of metal coping cap in section lengths not exceeding [12 feet (3.6 m)] <Insert dimension>, concealed anchorage; with corner units, end cap units, and concealed splice plates with finish matching coping caps.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Metallic-Coated Steel Sheet Coping Caps: Zinc-coated (galvanized) steel, nominal [0.028-inch (0.71-mm) thickness] [0.034-inch (0.86-mm) thickness] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. Surface: [Smooth, flat] [Embossed] finish.
 - b. Finish: [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] <Insert finish>.
 - c. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 3. Formed Aluminum Sheet Coping Caps: Aluminum sheet, [0.040 inch (1.02 mm) thick] [0.050 inch (1.27 mm) thick] [0.063 inch (1.60 mm) thick] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. Surface: [Smooth, flat] [Embossed] finish.
 - b. Finish: [Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic] <Insert finish>.
 - c. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 4. Extruded-Aluminum Coping Caps: Extruded aluminum, [0.080 inch (2.03 mm) thick] [0.125 inch (3.18 mm) thick] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. Finish: [Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic] <Insert finish>.
 - b. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 5. Formed Stainless Steel Sheet Coping Caps: Stainless steel sheet, nominal [0.0313-inch (0.795-mm) thickness] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. Finish: [ASTM A480/A480M No. 2B (bright, cold rolled)] [ASTM A480/A480M No. 3 (coarse, polished directional satin)] [ASTM A480/A480M No. 4 (bright, polished directional satin)] <Insert finish>.

6. Formed Copper Sheet Coping Caps: Copper sheet, [20 oz./sq. ft. (0.68 mm) thick] [weight (thickness) as required to meet performance requirements] <Insert weight (thickness)>.
 - a. Copper Finish: [Non-patinated, mill] [Pre-patinated dark brown] [Pre-patinated verdigris] <Insert finish>.
7. Corners: Factory mitered and [soldered] [continuously welded] [mechanically clinched and sealed watertight].
8. Special Fabrications: [Radiussed sections] [Arched sections] [Bullnose-face leg] [Two-way sloped coping cap] <Insert description>.
9. Coping-Cap Attachment Method: [Snap-on] [or] [face leg hooked to continuous cleat with back leg fastener exposed], fabricated from coping-cap material.
 - a. Snap-on Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches (300 mm) wide, with integral cleats.
 - b. Face-Leg Cleats: Concealed, continuous [galvanized-steel sheet] [stainless steel].

2.4 ROOF-EDGE SPECIALTIES

- A. Canted Roof-Edge Fascia and Gravel Stop <Insert drawing designation>: Manufactured, two-piece, roof-edge fascia consisting of [snap-on] [compression-clamped] metal fascia cover in section lengths not exceeding [12 feet (3.6 m)] <Insert dimension> and a continuous formed galvanized-steel sheet cant, 0.028 inch (0.71 mm) thick, minimum, with extended vertical leg terminating in a drip-edge cleat. Provide matching corner units.
 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Metallic-Coated Steel Sheet Fascia Covers: Zinc-coated (galvanized) steel, nominal [0.028-inch (0.71-mm) thickness] [0.034-inch (0.86-mm) thickness] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. Surface: [Smooth, flat] [Embossed] finish.
 - b. Finish: [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] <Insert finish>.
 - c. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 3. Formed Aluminum Sheet Fascia Covers: Aluminum sheet, [0.040 inch (1.02 mm) thick] [0.050 inch (1.27 mm) thick] [0.063 inch (1.60 mm) thick] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. Surface: [Smooth, flat] [Embossed] finish.
 - b. Finish: [Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic] <Insert finish>.
 - c. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.

4. Extruded-Aluminum Fascia Covers: Extruded aluminum, [**0.080 inch (2.03 mm) thick**] [**0.125 inch (3.18 mm) thick**] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. Finish: [Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic] <Insert finish>.
 - b. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 5. Corners: Factory mitered and [soldered] [continuously welded] [mechanically clinched and sealed watertight].
 6. Splice Plates: [Concealed] [Exposed], of same material, finish, and shape as fascia cover.
 7. Special Fabrications: [Radiussed sections] [Arched sections] [Bullnose fascia cover] [Cornice fascia cover] [Cove fascia cover] <Insert description>.
 8. Fascia Accessories: [Fascia extenders with continuous hold-down cleats] [Wall cap] [Soffit trim] [Overflow scuppers] [Overflow scuppers with perforated screens] [Spillout scuppers] [Downspout scuppers with integral conductor head and downspout adapters] [Downspout scuppers with integral conductor head and downspout adapters and perforated screens] <Insert description>.
- B. Roof-Edge Fascia: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding [**12 feet (3.6 m)**] <Insert dimension> and a continuous metal receiver with integral drip-edge cleat to engage fascia cover [**and secure single-ply roof membrane**]. Provide matching corner units.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Metallic-Coated Steel Sheet Fascia Covers: Zinc-coated (galvanized) steel, nominal [**0.028-inch (0.71-mm) thickness**] [**0.034-inch (0.86-mm) thickness**] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. Surface: [Smooth, flat] [Embossed] finish.
 - b. Finish: [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] <Insert finish>.
 - c. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 3. Formed Aluminum Sheet Fascia Covers: Aluminum sheet, [**0.040 inch (1.02 mm) thick**] [**0.050 inch (1.27 mm) thick**] [**0.063 inch (1.60 mm) thick**] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. Surface: [Smooth, flat] [Embossed] finish.
 - b. Finish: [Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic] <Insert finish>.

- c. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 4. Corners: Factory mitered and [soldered] [continuously welded] [mechanically clinched and sealed watertight].
 5. Splice Plates: [Concealed] [Exposed], of same material, finish, and shape as fascia cover.
 6. Receiver: [Galvanized-steel sheet, nominal 0.040-inch (1.02-mm) thickness] [Aluminum sheet, 0.050 inch (1.27 mm) thick] [Extruded aluminum, 0.080 inch (2.03 mm) thick] [Manufacturer's standard material and thickness].
 7. Special Fabrications: [Radiussed sections] [Arched sections] [Bullnose fascia cover] [Cornice fascia cover] [Cove fascia cover] <Insert description>.
 8. Fascia Accessories: [Fascia extenders with continuous hold-down cleats] [Wall cap] [Soffit trim] [Overflow scuppers] [Overflow scuppers with perforated screens] [Spillout scuppers] [Downspout scuppers with integral conductor head and downspout adapters] [Downspout scuppers with integral conductor head and downspout adapters and perforated screens] <Insert description>.
- C. One-Piece Gravel Stops: Manufactured, one-piece, metal gravel stop in section lengths not exceeding [12 feet (3.6 m)] <Insert dimension>, with a horizontal flange and vertical leg[, drain-through] fascia[terminating in a drip edge], and concealed splice plates of same material, finish, and shape as gravel stop. Provide matching corner units.
1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
 2. Metallic-Coated Steel Sheet Gravel Stops: Zinc-coated (galvanized) steel, nominal [0.028-inch (0.71-mm) thickness] [0.034-inch (0.86-mm) thickness] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. Surface: [Smooth, flat] [Embossed] finish.
 - b. Finish: [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] <Insert finish>.
 - c. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
 3. Formed Aluminum Sheet Gravel Stops: Aluminum sheet, [0.040 inch (1.02 mm) thick] [0.050 inch (1.27 mm) thick] [0.063 inch (1.60 mm) thick] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. Surface: [Smooth, flat] [Embossed] finish.
 - b. Finish: [Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic] <Insert finish>.
 - c. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.

4. Extruded-Aluminum Gravel Stops: Extruded aluminum, [**0.080 inch (2.03 mm) thick**] [**0.125 inch (3.18 mm) thick**] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. Finish: [Mill] [Two-coat fluoropolymer] [Three-coat fluoropolymer] [Two-coat mica fluoropolymer] [Three-coat metallic fluoropolymer] [Clear anodic] [Color anodic] <Insert finish>.
 - b. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
5. Formed Stainless Steel Sheet Gravel Stops: Stainless steel sheet, nominal [**0.0313-inch (0.795-mm) thickness**] [thickness as required to meet performance requirements] <Insert thickness>.
 - a. Finish: [ASTM A480/A480M No. 2B (bright, cold rolled)] [ASTM A480/A480M No. 3 (coarse, polished directional satin)] [ASTM A480/A480M No. 4 (bright, polished directional satin)] <Insert finish>.
6. Formed Copper Sheet Gravel Stops: Copper sheet, [**20 oz./sq. ft. (0.68 mm thick)**] [**weight (thickness)**] as required to meet performance requirements] <Insert **weight (thickness)**>.
 - a. Copper Finish: [Non-patinated, mill] [Pre-patinated dark brown] [Pre-patinated verdigris] <Insert finish>.
7. Corners: Factory mitered and [soldered] [continuously welded] [mechanically clinched and sealed watertight].
8. Accessories: [Fascia extenders with continuous hold-down cleats] [Wall cap] [Soffit trim] <Insert description>.

2.5 ROOF-EDGE DRAINAGE SYSTEMS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Gutters: Manufactured in uniform section lengths not exceeding [**12 feet (3.6 m)**] <Insert **dimension**>, with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least **1 inch (25 mm)** above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.
 1. Zinc-Coated Steel: Nominal [**0.028-inch (0.71-mm)**] [**0.034-inch (0.86-mm)**] <Insert **value**> thickness.
 2. Aluminum Sheet: [**0.032 inch (0.81 mm)**] [**0.040 inch (1.02 mm)**] [**0.050 inch (1.27 mm)**] [**0.063 inch (1.60 mm)**] <Insert value> thick.
 3. Copper Sheet: [**16 oz./sq. ft. (0.55 mm thick)**] [**20 oz./sq. ft. (0.68 mm thick)**] <Insert **value**>.
 4. Gutter Profile: [Style A] [Style B] [Style F] [Style G] [Style H] [Style I] [Style K] [Style K highback] [Half-round single bead] [Half-round highback] [Quarter round]

- [Ogee] [As indicated] <Insert style> according to SMACNA's "Architectural Sheet Metal Manual."
5. Embossed Surface: Embossed with design [as indicated by manufacturer's designations] [As selected by Architect from manufacturer's full range] <Insert description>.
 6. Applied Fascia Cover (Concealed Gutter): Exposed, formed [copper, 16 oz./sq. ft. (0.55 mm thick)] [aluminum, 0.040 inch (1.02 mm) thick] <Insert material and weight or thickness>, with factory-mitered corners, ends, and concealed splice joints.
 7. Corners: Factory mitered and [soldered] [continuously welded] [mechanically clinched and sealed watertight].
 8. Gutter Supports: [Gutter brackets] [Straps] [Spikes and ferrules] [Manufacturer's standard supports as selected by Architect] <Insert description> with finish matching the gutters.
 9. Special Fabrications: [Radiussed sections] <Insert description>.
 10. Gutter Accessories: [Continuous screened leaf guard with sheet metal frame] [Continuous hinged leaf guard of solid metal designed to shed leaves] [Continuous snap-in plastic leaf guard] [Bronze wire ball downspout strainer] [Wire ball downspout strainer] [Flat ends] [Bullnose ends for half-round gutter] <Insert description>.
- C. Downspouts: [Plain round] [Corrugated round] [Plain rectangular] [Corrugated rectangular] [Open-face rectangular] <Insert shape> complete with [machine-crimped] [mitered] [smooth-curve] elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
1. Zinc-Coated Steel: Nominal [0.028-inch (0.71-mm)] [0.034-inch (0.86-mm)] <Insert value> thickness.
 2. Formed Aluminum: [0.032 inch (0.81 mm)] [0.040 inch (1.02 mm)] [0.050 inch (1.27 mm)] [0.063 inch (1.60 mm)] <Insert value> thick.
 3. Extruded Aluminum: [0.125 inch (3.18 mm)] <Insert value> thick.
 4. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert value>.
- D. Parapet Scuppers: Manufactured with closure flange trim to exterior, 4-inch- (100-mm-) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. [Fasten gravel guard angles to base of scuppers.]
1. Zinc-Coated Steel: Nominal [0.028-inch (0.71-mm)] <Insert value> thickness.
 2. Formed Aluminum: [0.032 inch (0.81 mm)] <Insert value> thick.
 3. Stainless Steel: [0.0188 inch (0.477 mm)] <Insert value> thick.
 4. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight (thickness)>.
- E. Conductor Heads: Manufactured conductor heads, each with flanged back and stiffened top edge, and of dimensions and shape indicated, complete with outlet tube that nests into upper end of downspout[, exterior flange trim,] [and] [built-in overflow].
1. Zinc-Coated Steel: Nominal [0.028-inch (0.71-mm)] <Insert value> thickness.
 2. Formed Aluminum: [0.032 inch (0.81 mm)] <Insert value> thick.
 3. Stainless Steel: [0.0156 inch (0.396 mm)] <Insert value> thick.
 4. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight (thickness)>.

- F. Splash Pans: Fabricate from the following exposed metal:
1. Zinc-Coated Steel: Nominal [**0.028-inch (0.71-mm)**] <Insert value> thickness.
 2. Formed Aluminum: [**0.040 inch (1.02 mm)**] <Insert value> thick.
 3. Stainless Steel: [**0.0188 inch (0.477 mm)**] <Insert value> thick.
 4. Copper: [**16 oz./sq. ft. (0.55 mm thick)**] <Insert weight (thickness)>.
- G. Zinc-Coated Steel Finish: [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Two-coat mica fluoropolymer**] [**Three-coat metallic fluoropolymer**] <Insert finish>.
1. Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color>.
- H. Aluminum Finish: [**Mill**] [**Two-coat fluoropolymer**] [**Three-coat fluoropolymer**] [**Two-coat mica fluoropolymer**] [**Three-coat metallic fluoropolymer**] [**Clear anodic**] [**Color anodic**] <Insert finish>.
1. Color: [**Light bronze**] [**Medium bronze**] [**Dark bronze**] [**Black**] [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color>.
- I. Stainless Steel Finish: [**ASTM A480/A480M No. 2B (bright, cold rolled, unpolished)**] [**ASTM A480/A480M No. 3 (coarse, polished directional satin)**] [**ASTM A480/A480M No. 4 (bright, polished directional satin)**] <Insert finish>.
- J. Copper Finish: [**Non-patinated, mill**] [**Pre-patinated dark brown**] [**Pre-patinated verdigris**] <Insert finish>.

2.6 REGLETS AND COUNTERFLASHINGS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
1. Zinc-Coated Steel: Nominal [**0.022-inch (0.56-mm)**] [**0.028-inch (0.71-mm)**] <Insert value> thickness.
 2. Formed Aluminum: [**0.024 inch (0.61 mm)**] [**0.050 inch (1.27 mm)**] <Insert value> thick.
 3. Stainless Steel: [**0.0188 inch (0.477 mm)**] [**0.0250 inch (0.635 mm)**] <Insert value> thick.
 4. Copper: [**16 oz./sq. ft. (0.55 mm thick)**] <Insert weight (thickness)>.
 5. Corners: Factory mitered and [**soldered**] [**continuously welded**] [**mechanically clinched and sealed watertight**].
 6. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
 7. Stucco Type, Embedded: Provide reglets with upturned fastening flange and extension leg of length to match thickness of applied finish materials.

8. Concrete Type, Embedded: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
 9. Masonry Type, Embedded: Provide reglets with offset top flange for embedment in masonry mortar joint.
 10. Multiuse Type, Embedded: For multiuse embedment in **[cast-in-place concrete]** **[masonry mortar joints]**.
- C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by **4 inches (100 mm)** and in lengths not exceeding **[12 feet (3.6 m)]** **<Insert dimension>** designed to snap into **[reglets]** **[or]** **[through-wall-flashing receiver]** and compress against base flashings with joints lapped, from the following exposed metal:
1. Zinc-Coated Steel: Nominal **[0.022-inch (0.56-mm)]** **[0.028-inch (0.71-mm)]** **<Insert value>** thickness.
 2. Formed Aluminum: **[0.024 inch (0.61 mm)]** **[0.032 inch (0.81 mm)]** **<Insert value>** thick.
 3. Stainless Steel: **[0.0188 inch (0.477 mm)]** **[0.0250 inch (0.635 mm)]** **<Insert value>** thick.
 4. Copper: **[16 oz./sq. ft. (0.55 mm thick)]** **<Insert weight (thickness)>**.
- D. Accessories:
1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
 2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
- E. Zinc-Coated Steel Finish: **[Two-coat fluoropolymer]** **[Three-coat fluoropolymer]** **[Two-coat mica fluoropolymer]** **[Three-coat metallic fluoropolymer]** **<Insert finish>**.
1. Color: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** **<Insert color>**.
- F. Aluminum Finish: **[Mill]** **[Two-coat fluoropolymer]** **[Three-coat fluoropolymer]** **[Two-coat mica fluoropolymer]** **[Three-coat metallic fluoropolymer]** **[Clear anodic]** **[Color anodic]** **<Insert finish>**.
1. Color: **[Light bronze]** **[Medium bronze]** **[Dark bronze]** **[Black]** **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** **<Insert color>**.
- G. Stainless Steel Finish: **[ASTM A480/A480M No. 2B (bright, cold rolled, unpolished)]** **[ASTM A480/A480M No. 3 (coarse, polished directional satin)]** **[ASTM A480/A480M No. 4 (bright, polished directional satin)]** **<Insert finish>**.
- H. Copper Finish: **[Non-patinated, mill]** **[Pre-patinated verdigris]** **<Insert finish>**.

2.7 MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating designation.
- B. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
- C. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, alloy and temper recommended by manufacturer for type of use and finish indicated, finished as follows:
- D. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
- E. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 or H01 temper.

2.8 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet: Minimum **30 to 40 mils (0.76 to 1.0 mm)** thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
 - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 - 2. Thermal Stability: ASTM D1970/D1970M; stable after testing at **240 deg F (116 deg C)**.
 - 3. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus **20 deg F (29 deg C)**.
- B. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
- C. Slip Sheet: Rosin-sized building paper, **3-lb/100 sq. ft. (0.16-kg/sq. m)** minimum.

2.9 MISCELLANEOUS MATERIALS

- A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
 - 1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
 - 2. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
 - 3. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
 - 4. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
 - 5. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.
- B. Elastomeric Sealant: ASTM C920, elastomeric [**polyurethane**] [**silicone**] polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

- C. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- E. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.
- F. Solder for Copper: ASTM B32, [**lead-free solder**] [**Grade Sn50, 50 percent tin and 50 percent lead**] <Insert solder grade>.

2.10 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Coil-Coated Galvanized-Steel Sheet Finishes:
 - 1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with ASTM A755/A755M and coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
 - b. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
 - c. Two-Coat Mica Fluoropolymer: AAMA 621. Fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
 - d. Three-Coat Metallic Fluoropolymer: AAMA 621. Fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].

- e. Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.

E. Coil-Coated Aluminum Sheet Finishes:

1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
 - b. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
 - c. Two-Coat Mica Fluoropolymer: AAMA 2605. Fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
 - d. Three-Coat Metallic Fluoropolymer: AAMA 2605. Fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
 - e. Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.
2. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**] [**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
3. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**] [**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

F. Aluminum Extrusion Finishes:

1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer: AAMA [**2604**] [**2605**]. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - b. Three-Coat Fluoropolymer: AAMA [**2604**] [**2605**]. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to

- exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
- c. Two-Coat Mica Fluoropolymer: AAMA [2604] [2605]. Fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - d. Three-Coat Metallic Fluoropolymer: AAMA [2604] [2605]. Fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - e. Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.
2. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
 3. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.
- G. Copper Sheet Finishes:
1. Non-Patinated Finish: Mill finish.
 2. Pre-Patinated Finish: Chemically treated according to ASTM B882.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.
- C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply wrinkle free, in shingle fashion to shed water, and with end laps of not less than **6 inches (152 mm)** staggered **24 inches (610 mm)** between courses. Overlap side edges not less than **3-1/2 inches (90 mm)**. Roll laps with roller. Cover underlayment within 14 days.

1. Apply continuously under [copings] [roof-edge specialties] [and] [reglets and counterflashings].
 2. Coordinate application of self-adhering sheet underlayment under roof specialties with requirements for continuity with adjacent air barrier materials.
- B. Felt Underlayment: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than **2 inches (50 mm)**.
- C. Slip Sheet: Install with tape or adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than **2 inches (50 mm)**.

3.3 INSTALLATION, GENERAL

- A. Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.
1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
 2. Provide uniform, neat seams with minimum exposure of solder and sealant.
 3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
 4. Torch cutting of roof specialties is not permitted.
 5. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Coat concealed side of [uncoated aluminum] [and] [stainless steel] roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
- C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
1. Space movement joints at a maximum of [**12 feet (3.6 m)**] <Insert dimension> with no joints within [**18 inches (450 mm)**] <Insert dimension> of corners or intersections unless otherwise indicated on Drawings.
 2. When ambient temperature at time of installation is between **40 and 70 deg F (4 and 21 deg C)**, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
- D. Fastener Sizes: Use fasteners of sizes that penetrate [**wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws**]

[substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance] <Insert size requirement>.

- E. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.
- F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below **40 deg F (4 deg C)**.
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of **1-1/2 inches (38 mm)**; however, reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.4 INSTALLATION OF COPINGS

- A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.
 - 1. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at **[30-inch (762-mm) centers] [40-inch (1016-mm) centers] [manufacturer's required spacing that meets performance requirements] <Insert spacing>**.
 - 2. Interlock face-leg drip edge into continuous cleat anchored to substrate at **[24-inch (610-mm) centers] [16-inch (406-mm) centers] [manufacturer's required spacing that meets performance requirements] <Insert spacing>**. Anchor back leg of coping with screw fasteners and elastomeric washers at **[24-inch (610-mm) centers] [16-inch (406-mm) centers] [manufacturer's required spacing that meets performance requirements] <Insert spacing>**.

3.5 INSTALLATION OF ROOF-EDGE SPECIALITIES

- A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.6 INSTALLATION OF ROOF-EDGE DRAINAGE SYSTEMS

- A. Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

- B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than [12 inches (305 mm)] [24 inches (610 mm)] [30 inches (762 mm)] <Insert dimension> apart. Attach ends with rivets and [seal with sealant] [solder] to make watertight. Slope to downspouts.
1. Install gutter with expansion joints at locations indicated but not exceeding [50 feet (15.2 m)] <Insert dimension> apart. Install expansion-joint caps.
 2. Install continuous leaf guards on gutters with noncorrosive fasteners, [removable] [hinged to swing open] for cleaning gutters.
- C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately [60 inches (1500 mm)] <Insert dimension> o.c.
1. Provide elbows at base of downspouts at grade to direct water away from building.
 2. Connect downspouts to underground drainage system indicated.
- D. Splash Pans: Install where downspouts discharge on [low-slope roofs] <Insert surface>. Set in [asphalt roofing cement] [elastomeric sealant].
- E. Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
1. Anchor scupper closure trim flange to exterior wall and seal or solder to scupper.
 2. Loosely lock front edge of scupper with conductor head.
 3. Seal or solder exterior wall scupper flanges into back of conductor head.
- F. Conductor Heads: Anchor securely to wall with elevation of conductor top edge 1 inch (25 mm) below [scupper] [gutter] discharge.

3.7 INSTALLATION OF REGLETS AND COUNTERFLASHINGS

- A. Coordinate installation of reglets and counterflashings with installation of base flashings.
- B. Embedded Reglets: See [Section 033000 "Cast-in-Place Concrete"] [and] [Section 042000 "Unit Masonry"] for installation of reglets.
- C. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches (100 mm) over top edge of base flashings.
- D. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches (100 mm) over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with butyl sealant. Fit counterflashings tightly to base flashings.

3.8 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.
- D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077100

SECTION 077129 - MANUFACTURED ROOF EXPANSION JOINTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flanged bellows-type roof expansion joints.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wooden curbs or cants for mounting roof expansion joints.
2. Section 076200 "Sheet Metal Flashing and Trim" for shop- and field-fabricated sheet metal expansion-joint systems, flashing, and other sheet metal items.
3. Section 077200 "Roof Accessories" for manufactured and prefabricated metal roof curbs.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Flanged bellows-type roof expansion joints.

B. Shop Drawings: For roof expansion joints.

1. Include plans, elevations, sections, and attachment details.
2. Include details of splices, intersections, transitions, fittings, method of field assembly, and location and size of each field splice.
3. Provide isometric drawings of intersections, terminations, changes in joint direction or planes, and transition to other expansion joint systems depicting how components interconnect with each other and adjacent construction to allow movement and achieve waterproof continuity.

C. Samples: For each exposed product and for each color specified, 6 inches (150 mm) in size.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranties: For special warranties.

1.4 WARRANTY

- ##### A. Special Warranty: Manufacturer and Installer agree to repair or replace roof expansion joints and components that leak, deteriorate beyond normal weathering, or otherwise fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint seals, failure of connections, and other detrimental effects.
 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 FLANGED BELLOWS-TYPE ROOF EXPANSION JOINTS

- A. Flanged Bellows-Type Roof Expansion Joint: Factory-fabricated, continuous, waterproof, joint cover consisting of exposed membrane bellows laminated to flexible, closed-cell support foam, and secured along each edge to 3- to 4-inch- (76- to 100-mm-) wide metal flange.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Architectural Art Manufacturing; a division of Pittcon Architectural Metals, LLC.
 - b. Balco; a CSW Industrials Company.
 - c. Johns Manville; a Berkshire Hathaway company.
 - d. inpro Corporation.
 2. Source Limitations: Obtain flanged bellows-type roof expansion joints approved by roofing manufacturer and that are part of roofing membrane warranty.
 3. Joint Movement Capability: Plus and minus 25 percent of joint size.
 4. Bellows: EPDM flexible membrane, nominal 60 mils (1.5 mm) thick.
 5. Flanges: Stainless steel, 0.0188 inch (0.477 mm) thick.
 6. Configuration: as indicated on Drawings.
 7. Corner, Intersection, and Transition Units: Provide factory-fabricated units for corner and joint intersections and horizontal and vertical transitions including those to other building expansion joints.
 8. Cover Membrane: EPDM flexible membrane, factory laminated to bellows and covering entire joint assembly and curbs.
 - a. Color: White.
 9. Accessories: Provide splicing units, adhesives, and other components as recommended by roof-expansion-joint manufacturer for complete installation.
 10. Secondary Seal: Continuous, waterproof membrane within joint and attached to substrate on sides of joint below the primary bellows assembly.

- a. Thermal Insulation: Fill space above secondary seal with manufacturer's standard, factory-installed mineral-fiber insulation; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E84.

B. Materials:

1. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
2. EPDM Membrane: ASTM D4637/D4637M, type standard with manufacturer for application.

2.3 MISCELLANEOUS MATERIALS

A. Adhesives: As recommended by roof-expansion-joint manufacturer.

1. Verify adhesives have a VOC content of 70 g/L or less.
2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to withstand design loads.

1. Exposed Fasteners: Gasketed. Use screws with hex washer heads matching color of material being fastened.

C. Mineral-Fiber Blanket: ASTM C665.

D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joint openings, substrates, and expansion-control joint systems that interface with roof expansion joints, for suitable conditions where roof expansion joints will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions for handling and installing roof expansion joints.
 1. Anchor roof expansion joints securely in place, with provisions for required movement. Use fasteners, protective coatings, sealants, and miscellaneous items as required to complete roof expansion joints.

2. Install roof expansion joints true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
 3. Provide for linear thermal expansion of roof-expansion-joint materials.
 4. Provide uniform profile of roof expansion joint throughout its length; do not stretch or squeeze membranes.
 5. Provide uniform, neat seams.
 6. Install roof expansion joints to fit substrates and to result in watertight performance.
- B. Directional Changes: Install factory-fabricated units at directional changes to provide continuous, uninterrupted, and watertight joints.
- C. Splices: Splice roof expansion joints to provide continuous, uninterrupted, and waterproof joints.
1. Install waterproof splices and prefabricated end dams to prevent leakage of secondary-seal membrane.
- D. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

END OF SECTION 077129

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof curbs.
2. Pipe and duct supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
2. Section 077100 "Roof Specialties" for manufactured fasciae, copings, gravel stops, gutters and downspouts, and counterflashing.
3. Section 077129 "Manufactured Roof Expansion Joints" for manufactured roof expansion-joint covers.

1.2 COORDINATION

- A.** Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B.** Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof accessories.

1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

- D. Delegated Design Submittals: For roof curbs indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.
 - 2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
 - 1. Size and location of roof accessories specified in this Section.
 - 2. Method of attaching roof accessories to roof or building structure.
 - 3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
 - 4. Required clearances.
- B. Sample Warranties: For manufacturer's special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.6 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design roof curbs and equipment supports to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Wind-Restraint Performance: As indicated on Drawings.

2.2 ROOF CURBS

- A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Supported Load Capacity: Coordinate load capacity with information on Shop Drawings of equipment to be supported.
- D. Steel: Zinc-coated (galvanized) steel sheet, **0.064 inch (1.63 mm)** thick.
 - 1. Finish: Baked enamel or powder coat.
 - 2. Color: As selected by Architect from manufacturer's full range.
- E. Construction:
 - 1. Curb Profile: Manufacturer's standard compatible with roofing system.
 - 2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
 - 3. Fabricate curbs to minimum height of **12 inches (305 mm)** above roofing surface unless otherwise indicated.
 - 4. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange or by use of leveler frame.
 - 5. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
 - 6. Insulation: Factory insulated with **1-1/2-inch- (38-mm-)** thick glass-fiber board insulation.

7. Liner: Same material as curb, of manufacturer's standard thickness and finish.
8. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.

2.3 PIPE AND DUCT SUPPORTS

- A. Fixed-Height Cradle-Type Pipe Supports: Polycarbonate pipe stand accommodating up to **1-1/2-inch- (38-mm-)** diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

2.4 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, **G90 (Z275)** coating designation.
 1. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils (0.05 mm)**.
 2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of **0.5 mil (0.013 mm)**.
- B. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.
- C. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.
- D. Steel Pipe: ASTM A53/A53M, galvanized.

2.5 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Glass-Fiber Board Insulation: ASTM C726, nominal density of **3 lb/cu. ft. (48 kg/cu. m)**, thermal resistivity of **4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C)**, thickness as indicated.
- C. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- D. Underlayment:
 1. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
 2. Polyethylene Sheet: **6-mil- (0.15-mm-)** thick polyethylene sheet complying with ASTM D4397.

3. Slip Sheet: Building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum, rosin sized.
 4. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
- E. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.
 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
- F. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- G. Elastomeric Sealant: ASTM C920, elastomeric [polyurethane] [silicone] polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
- H. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.
- I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.6 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install roof accessories according to manufacturer's written instructions.
 - 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 - 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 - 1. Underlayment: Where installing roof accessories directly on cementitious substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
 - 2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. Roof Curb Installation: Install each roof curb so top surface is level.
- D. Pipe Support Installation: Comply with MSS SP-58 and MSS SP-89. Install supports and attachments as required to properly support piping. Arrange for grouping of parallel runs of horizontal piping, and support together.
 - 1. Pipes of Various Sizes: Space supports for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
- E. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting."
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Clean off excess sealants.

Maryland State Police
Tactical Administration Center
PA-745-210-001

- E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.

B. Related Requirements:

1. Section 078443 "Joint Firestopping" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. [Product Data](#): For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Listed System Designs: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.4 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval Standard for Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
 - 1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

- a. Penetration firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.
 - 1) UL in its online directory "Product iQ."
 - 2) Intertek Group in its "Directory of Building Products."
 - 3) FM Approvals in its "Approval Guide."

2.3 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems are to be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479.
 1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
 2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.
- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479.
 1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor penetrated.
 2. T-Rating: At least one hour, but not less than the fire-resistance rating of the floor. The following floor penetrations do not require a T-rating:
 - a. Those within the cavity of a wall.
 - b. Floor, tub, or shower drains within a concealed space.
 - c. **4-inch (200-mm)** or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.
- D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479.
 1. L-Rating: Not exceeding **5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m)** of penetration opening and no more than **50-cfm (0.024-cu. m/s)** cumulative total for any **100 sq. ft. (9.3 sq. m)** at both ambient and elevated temperatures.
- E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.
 1. Verify sealant has a VOC content of 250 g/L or less.
 2. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of

Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

- F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
 - 1. Permanent forming/damming/backing materials.
 - 2. Substrate primers.
 - 3. Collars.
 - 4. Steel sleeves.

2.4 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric strips for use around combustible penetrants.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Compressible, removable, and reusable intumescent pillows encased in fire-retardant polyester or glass-fiber cloth. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.
- K. Fire-Rated Cable Sleeve Kits: Complete kits designed for new or existing cable penetrations through walls to accept standard accessories.

- L. Thermal Wrap: Flexible protective wrap tested and listed for up to 2-hour fire ratings in accordance with ASTM E814/UL 1479 for membrane penetrations or ASTM E1725/UL 1724 for thermal barrier and circuit integrity protection.
- M. Fire-Rated Cable Pathways: Single or gangable device modules composed of a steel raceway with integral intumescent material and requiring no additional action in the form of plugs, twisting closure, putty, pillows, sealant, or otherwise to achieve fire and air-leakage ratings.
- N. Wall-Opening Protective Materials: Intumescent, non-curing putty pads or self-adhesive inserts for protection of electrical switch and receptacle boxes.
- O. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use around rectangular steel HVAC ducts without fire dampers.
- P. Firestop Plugs: Flexible, re-enterable, intumescent, foam-rubber plug for use in blank round openings and cable sleeves.
- Q. Fire-Rated Cable Grommet: Molded two-piece grommet made of plenum-grade polymer and foam inner core for sealing small cable penetrations in gypsum walls up to **1/2 inch (13 mm)** diameter.
- R. Closet Flange Gasket: Molded, single-component, flexible, intumescent gasket for use beneath a water closet (toilet) flange in floor applications.
- S. Endothermic Wrap: Flexible, insulating, fire-resistant, endothermic wrap for protecting membrane penetrations of utility boxes, critical electrical circuits, communications lines, and fuel lines.

2.5 MIXING

- A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

- A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- C. Install fill materials by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.
 - 1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).

- B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within **6 inches (150 mm)** of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 2. Contractor's name, address, and phone number.
 3. Designation of applicable testing and inspecting agency.
 4. Date of installation.
 5. Manufacturer's name.
 6. Installer's name.

3.5 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 078443 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated construction.
2. Joints at exterior curtain-wall/floor intersections.
3. Joints in smoke barriers.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers and for wall identification.
2. Section 092216 "Non-Structural Metal Framing" for firestop tracks for metal-framed partition heads.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Joints in or between fire-resistance-rated construction.
2. Joints at exterior curtain-wall/floor intersections.
3. Joints in smoke barriers.

B. Sustainable Design Submittals:

1. **Product Data:** For sealants, indicating VOC content.
2. **Laboratory Test Reports:** For sealants, indicating compliance with requirements for low-emitting materials.

C. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

1. **Engineering Judgments:** Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

- B. Listed System Designs: For each joint firestopping system, for tests performed by a qualified testing agency.

1.4 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

- A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
 - 1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:

- a. Joint firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with Listed System Designs published by a qualified testing agency.

- 1) UL in its online directory "Product iQ."
- 2) Intertek Group in its "Directory of Building Products."

- B. Rain/Water Resistance: For perimeter fire-barrier system applications, where inclement weather or greater-than-transient water exposure is expected, use products that dry rapidly and cure in the presence of atmospheric moisture sufficient to pass ASTM D6904 early rain-resistance test (24-hour exposure).

2.3 JOINT FIRESTOPPING SYSTEMS

- A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems must accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

1. Joint firestopping systems that are compatible with one another, with the substrates forming openings, and with penetrating items, if any.
2. Provide products that, upon curing, do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture.
3. Provide firestop products that do not contain ethylene glycol.

- B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.

1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

- C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide joint firestopping systems with rating determined per ASTM E2307.

1. F-Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.

- D. Joints in Smoke Barriers: Provide joint firestopping systems with ratings determined per UL 2079 based on testing at a positive pressure differential of **0.30-inch wg (74.7 Pa)**.

1. L-Rating: Not exceeding **5.0 cfm/ft. (0.00775 cu. m/s x m)** of joint at both ambient and elevated temperatures.

- E. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.

1. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 ACCESSORIES

- A. Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Before installing joint firestopping systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
 - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
 - 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Apply a suitable bond-breaker to prevent three-sided adhesion in applications where this condition occurs, such as the intersection of a gypsum wall to floor or roof assembly where the joint is backed by a steel ceiling runner or track.

3.3 INSTALLATION

- A. General: Install joint firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:
1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
 2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
 3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.
1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 ft. (4.57 m) from end of wall and at intervals not exceeding 30 ft. (9.14 m).
- B. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 2. Contractor's name, address, and phone number.
 3. Designation of applicable testing agency.
 4. Date of installation.
 5. Manufacturer's name.
 6. Installer's name.

3.5 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections in accordance with ASTM E2393.
- B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.
- C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

- A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.
- B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated joint firestopping systems immediately and install new materials to produce joint firestopping systems complying with specified requirements.

3.7 JOINT FIRESTOPPING SYSTEM SCHEDULE

- A. Where UL-classified systems are indicated, they refer to system numbers in UL's online directory "Product iQ" under product Category XHBN or Category XHDG.
- B. Where Intertek Group-listed systems are indicated, they refer to design numbers in Intertek Group's "Directory of Building Products" under product category Firestop Systems].
- C. Wall-to-Wall, Joint Firestopping Systems: **<Insert drawing designation>**.
 - 1. UL-Classified Systems: WW-[D] [S]-**<Insert four-digit number>** [0000-0999] [1000-1999] [2000-2999] [3000-3999] [4000-4999].
 - 2. Assembly Rating: [1 hour] [2 hours] **<Insert number of hours>**.
 - 3. Nominal Joint Width: [As indicated] **<Insert dimension>**.
 - 4. Movement Capabilities: [Class I] [Class II] [Class III] - **<Insert number>** percent[**compression or extension**].
 - 5. L-Rating at Ambient: Less than **<Insert cfm/ft. (cu. m/s x m)>**.
 - 6. L-Rating at 400 Deg F (204 Deg C): Less than **<Insert cfm/ft. (cu. m/s x m)>**.
- D. Floor-to-Wall, Joint Firestopping Systems:
 - 1. UL-Classified Systems: FW- S-0001.
 - 2. Assembly Rating: 1 hour.
- E. Head-of-Wall, Fire-Resistive Joint Firestopping Systems:
 - 1. UL-Classified Systems: HW-D-0488.
 - 2. Assembly Rating: 1 hour.
- F. Bottom-of-Wall, Joint Firestopping Systems:
 - 1. UL-Classified Systems: BW- S-0007.
 - 2. Assembly Rating: 1 hour.
- G. Wall-to-Wall, Joint Firestopping Systems:
 - 1. UL-Classified Systems: WW-D-0074.

Maryland State Police
Tactical Administration Center
PA-745-210-001

2. Assembly Rating: 1 hour.

END OF SECTION 078443

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Mildew-resistant joint sealants.
3. Butyl joint sealants.
4. Latex joint sealants.

B. Related Requirements:

1. Section 079219 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Joint sealants.
2. Joint-sealant backing materials.

B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in **1/2-inch- (13-mm-)** wide joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

E. Sustainable Design Submittals:

1. **Product Data:** For sealants, indicating VOC content.
2. **Laboratory Test Reports:** For sealants, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Manufacturers' special warranties.
- B. Installer's special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.6 MOCKUPS

- A. Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.7 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer[**or are below 40 deg F (5 deg C)**].
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 - 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 - 2. Disintegration of joint substrates from causes exceeding design specifications.
 - 3. Mechanical damage caused by individuals, tools, or other outside agents.
 - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain joint sealants from single manufacturer for each sealant type.

2.2 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. VOC Content: Verify sealants and sealant primers comply with the following:
 - 1. Architectural sealants have a VOC content of [250] g/L or less.
 - 2. Sealants and sealant primers for nonporous substrates have a VOC content of [250] g/L or less.
 - 3. Sealants and sealant primers for porous substrates have a VOC content of [775] g/L or less.
 - 4. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [GE Construction Sealants; Momentive Performance Materials Inc.](#)
- b. [Pecora Corporation.](#)
- c. Sika Corporation - Building Components.
- d. [The Dow Chemical Company.](#)

2.4 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [GE Construction Sealants; Momentive Performance Materials Inc.](#)
 - b. [Pecora Corporation.](#)
 - c. Sika Corporation - Building Components.
 - d. [The Dow Chemical Company.](#)
 - e. [Tremco Incorporated.](#)

2.5 BUTYL JOINT SEALANTS

- A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Bostik; Arkema.](#)
 - b. [Pecora Corporation.](#)
 - c. Sika Corporation - Building Components.

2.6 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Pecora Corporation.](#)
 - b. [Sherwin-Williams Company \(The\).](#)
 - c. [Tremco Incorporated.](#)

2.7 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin) Type O (open-cell material) Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 3. Remove laitance and form-release agents from concrete.
 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.

3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 1. Remove excess sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.

3.4 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079200

SECTION 079219 - ACOUSTICAL JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Acoustical joint sealants.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for elastomeric, latex, and butyl-rubber-based joint sealants for nonacoustical applications.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Acoustical joint sealants.

B. Acoustical Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

C. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each type of acoustical joint sealant, for tests performed by qualified testing agency.

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Warranty Documentation:
 - 1. Manufacturers' special warranties.
 - 2. Installer's special warranties.

1.5 WARRANTY

- A. Installer's Special Warranty: Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Manufacturer's Special Warranty: Manufacturer agrees to furnish acoustical joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ACOUSTICAL JOINT SEALANTS

- A. Acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies in accordance with ASTM E90.
 - 1. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Acoustical Sealant for Exposed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C834.
 - 1. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.
- C. Acoustical Sealant for Concealed Joints: Manufacturer's standard nonsag, nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber acoustical sealant.

2.2 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by acoustical joint-sealant manufacturer where required for adhesion of sealant to joint substrates.

- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive acoustical joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where recommended by acoustical joint-sealant manufacturer. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF ACOUSTICAL JOINT SEALANTS

- A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.
- B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C919, ASTM C1193, and manufacturer's written instructions for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.

- C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

3.4 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of acoustical joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect acoustical joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079219

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Interior standard steel doors and frames.
2. Exterior standard steel doors and frames.

B. Related Requirements:

1. Section 087111 "Door Hardware (Descriptive Specification)" for door hardware for hollow-metal doors.

1.2 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings in accordance with NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.3 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, temperature-rise ratings, and finishes.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
7. Details of anchorages, joints, field splices, and connections.
8. Details of accessories.
9. Details of moldings, removable stops, and glazing.

- D. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly and thermally rated door assemblies for tests performed by a qualified testing agency indicating compliance with performance requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum **4-inch (102-mm)** high wood blocking. Provide minimum **1/4-inch (6-mm)** space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Ceco Door; AADG, Inc.; ASSA ABLOY.
 2. Curries, AADG, Inc.; ASSA ABLOY Group.
 3. Republic Doors and Frames; a Allegion brand.
 4. Steelcraft; Allegion plc.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.
- B. Fire-Rated, Borrowed-Lite Assemblies: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing in accordance with NFPA 257 or UL 9.
- C. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than **0.40 deg Btu/F x h x sq. ft. (2.27 W/K x sq. m)** when tested in accordance with ASTM C1363 or ASTM E1423.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A. At locations indicated in the Door and Frame Schedule.
1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: **1-3/4 inches (44.5 mm)**.
 - c. Face: Metallic-coated steel sheet, minimum thickness of **0.053 inch (1.3 mm)**.
 - d. Edge Construction: Model 1, Full Flush.
 - e. Edge Bevel: Provide manufacturer's standard beveled or square edges.

- f. Core: Manufacturer's standard.
 - g. Fire-Rated Core: Manufacturer's standard laminated mineral board core for fire-rated doors.
 2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
 - b. Sidelite Frames: Fabricated from same thickness material as adjacent door frame.
 - c. Construction: Knocked down.
 3. Exposed Finish: Prime.
 - C. Maximum-Duty Doors and Frames: ANSI/SDI A250.8, Level 4; ANSI/SDI A250.4, Level A. At locations indicated in the Door and Frame Schedule.
 1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches (44.5 mm).
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.067 inch (1.7 mm).
 - d. Edge Construction: Model 1, Full Flush.
 - e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
 - f. Core: Manufacturer's standard.
 - g. Fire-Rated Core: Manufacturer's standard laminated mineral board core for fire-rated doors.
 2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch (1.7 mm).
 - b. Construction: Full profile welded.
 3. Exposed Finish: Prime.
- 2.4 EXTERIOR STANDARD STEEL DOORS AND FRAMES
 - A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
 - B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A. At locations indicated in the Door and Frame Schedule.
 1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches (44.5 mm).
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A60 (ZF180) coating.
 - d. Edge Construction: Model 1, Full Flush.

- e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
 - f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
 - g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
 - h. Core: Polyisocyanurate.
 - i. Fire-Rated Core: Manufacturer's standard laminated mineral board core for fire-rated doors.
2. Frames:
- a. Materials: Metallic-coated steel sheet, minimum thickness of **0.053 inch (1.3 mm)**, with minimum **A60 (ZF180)** coating.
 - b. Construction: Full profile welded. Provide thermally-broken construction.
3. Exposed Finish: Prime.
- C. Maximum-Duty Doors and Frames: ANSI/SDI A250.8, Level 4; ANSI/SDI A250.4, Level A. At locations indicated in the Door and Frame Schedule.
1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: **1-3/4 inches (44.5 mm)**.
 - c. Face: Metallic-coated steel sheet, minimum thickness of **0.067 inch (1.7 mm)**, with minimum **A60 (ZF180)** coating.
 - d. Edge Construction: Model 1, Full Flush.
 - e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
 - f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
 - g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
 - h. Core: Polyisocyanurate.
 - i. Fire-Rated Core: Manufacturer's standard laminated mineral board core for fire-rated doors.
 2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of **0.067 inch (1.7 mm)**, with minimum **A60 (ZF180)** coating.
 - b. Construction: Full profile welded. Provide thermally-broken construction.
 3. Exposed Finish: Prime.

2.5 BORROWED LITES

- A. Fabricate of metallic-coated steel sheet, minimum thickness of **0.042 inch (1.0 mm)**.

- B. Construction: Knocked down.
- C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.
- D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.6 HOLLOW-METAL PANELS

- A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

2.7 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 - 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each **24 inches (610 mm)** of frame height above **7 feet (2.1 m)**.
 - 3. Postinstalled Expansion Anchor: Minimum **3/8-inch- (9.5-mm-)** diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Material: ASTM A879/A879M, Commercial Steel (CS), **04Z (12G)** coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

2.8 MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- C. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

- D. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.
- F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- G. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.
- H. Glazing: Comply with requirements in Section 088000 "Glazing."

2.9 FABRICATION

- A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum **3/4 inch (19 mm)** beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 - 1. Sidelite Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.
- D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with [beveled] [square] stops unless otherwise indicated.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

2.10 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

- A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.
- B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.
 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.

- b. Install frames with removable stops located on secure side of opening.
 2. Fire-Rated Openings: Install frames in accordance with NFPA 80.
 3. Floor Anchors: Secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 4. Solidly pack mineral-fiber insulation inside frames.
 5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
 6. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus **1/16 inch (1.6 mm)**, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus **1/16 inch (1.6 mm)**, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
 1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
 2. Fire-Rated Doors: Install doors with clearances in accordance with NFPA 80.
 3. Smoke-Control Doors: Install doors in accordance with NFPA 105.
- D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 REPAIR

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-core doors with wood-veneer faces.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Requirements:

1. Section 088000 "Glazing" for glass view panels in flush wood doors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of door. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.

B. Sustainable Design Submittals:

1. [Chain-of-Custody Certificates](#): For certified wood products. Include statement of costs.
2. [Chain-of-Custody Qualification Data](#): For manufacturer and vendor.
3. [Laboratory Test Reports](#): For adhesives, indicating compliance with requirements for low-emitting materials.
4. [Laboratory Test Reports](#): For composite wood products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:

1. Dimensions and locations of blocking.
2. Dimensions and locations of mortises and holes for hardware.
3. Dimensions and locations of cutouts.
4. Undercuts.
5. Requirements for veneer matching.
6. Doors to be factory finished and finish requirements.
7. Fire-protection ratings for fire-rated doors.

D. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For door inspector.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.

1.5 QUALITY ASSURANCE

- A. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.
- B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.
- C. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies complies with qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:
 1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in plastic bags or cardboard cartons.
- C. Mark each door on bottom rail with opening number used on Shop Drawings.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during remainder of construction period.

1.8 WARRANTY

- A. A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Wood Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-

protection ratings indicated on Drawings, based on testing at positive pressure in accordance with UL 10C.

1. **Oversize Fire-Rated Door Assemblies:** For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
- B. **Smoke- and Draft-Control Door Assemblies:** Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

2.2 MANUFACTURERS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [Algoma Hardwoods, Inc.](#)
 2. [Eggers Industries.](#)
 3. [Graham Wood Doors; ASSA ABLOY Group Company.](#)
 4. [Mohawk Flush Doors, Inc.](#)
 5. [VT Industries Inc.](#)
- B. **Source Limitations:** Obtain flush wood doors from single manufacturer.

2.3 FLUSH WOOD DOORS, GENERAL

- A. **Quality Standard:** In addition to requirements specified, comply with AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."
 1. Contract Documents contain selections chosen from options in quality standard and additional requirements beyond those of quality standard. Comply with those selections and requirements in addition to quality standard.
- B. **WDMA I.S.1-A Performance Grade:** Heavy Duty.
- C. **Fire-Rated Wood Doors:** Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252, or UL 10C.
 1. **Temperature-Rise Limit:** At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
 2. **Cores:** Provide core specified or mineral core as needed to provide fire-protection rating indicated.
 3. **Edge Construction:** Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
 4. **Pairs:** Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
 5. **Pairs:** Provide formed-steel edges and astragals with intumescent seals.
 - a. Finish steel edges and astragals with baked enamel same color as doors.

- D. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.
- E. Particleboard-Core Doors:
 - 1. Particleboard: ANSI A208.1, Grade LD-1.
 - 2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
 - 3. Provide doors with glued-wood-stave or structural-composite-lumber cores instead of particleboard cores for doors indicated to receive exit devices.
- F. Mineral-Core Doors:
 - 1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
 - 2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
 - 3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - a. Screw-Holding Capability: 475 lbf per WDMA T.M.-10.

2.4 VENEER-FACED DOORS FOR TRANSPARENT FINISH

- A. Interior Solid-Core Doors:
 - 1. Grade: Premium with Grade AA faces.
 - 2. Species: Select white maple.
 - 3. Cut: Quarter sawn.
 - 4. Match between Veneer Leaves: Slip match.
 - 5. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
 - 6. Exposed Vertical Edges: Same species as faces or a compatible species - edge Type A.
 - 7. Core: Particleboard.
 - 8. Construction: Five plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering.

2.5 LIGHT FRAMES

- A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.
 - 1. Wood Species: Same species as door faces.
 - 2. Profile: Flush rectangular beads.
 - 3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.
- B. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch-thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated.

2.6 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 - 1. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
 - 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 - 2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- C. Openings: Factory cut and trim openings through doors.
 - 1. Light Openings: Trim openings with moldings of material and profile indicated.
 - 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."

2.7 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 - 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Transparent Finish:
 - 1. Grade: Custom.
 - 2. Finish: AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" System 5, conversion varnish.
 - 3. Staining: Refer to Interior Finish Schedule on Drawing ID001 for requirements.
 - 4. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
 - 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 - 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Section 087100 "Door Hardware."

- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
 - 1. Install fire-rated doors according to NFPA 80.
 - 2. Install smoke- and draft-control doors according to NFPA 105.
- C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 FIELD QUALITY CONTROL

- A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
 - 1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80.

3.4 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Access doors and frames.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details material descriptions, dimensions of individual components and profiles, and finishes.
- B. Product Schedule: For access doors and frames.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES

- A. Flush Access Doors with Exposed Flanges:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Babcock-Davis.
 - b. Elmdor; Morris Group International, Inc.
 - c. Larsen's Manufacturing Company.
 - d. Milcor; Hart & Cooley, Inc.
 - e. Nystrom, Inc.
 2. Description: Face of door flush with frame, with exposed flange and concealed hinge.
 3. Locations: Wall and ceiling.
 4. Door Size: As required for access to equipment and systems.
 5. Metallic-Coated Steel Sheet for Door: Nominal **0.064 inch (1.63 mm)**, 16 gage, factory primed.
 6. Latch and Lock: Cam latch, screwdriver operated.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

- C. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.
- D. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- E. Frame Anchors: Same material as door face.
- F. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.2 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.

2.3 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 FIELD QUALITY CONTROL

- A. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- B. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.4 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083113

SECTION 083213 - SLIDING ALUMINUM-FRAMED GLASS DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes sliding aluminum-framed glass doors, sidelights, and transoms for interior locations.
- B. Related Requirements:
 - 1. Section 084113 "Aluminum-Framed Entrances and Storefronts" for coordinating finish among aluminum fenestration units on the building exterior.
 - 2. Section 088000 "Glazing" for glass and glazing requirements.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions.
- B. Sustainable Design Submittals:
 - 1. **Product Data:** For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. **Product Certificates:** For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
 - 3. **Environmental Product Declaration:** For each product.
 - 4. **Health Product Declaration:** For each product.
 - 5. **Sourcing of Raw Materials:** Corporate sustainability report for each manufacturer.
- C. Shop Drawings: For sliding aluminum-framed glass doors.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification data.
- B. Product test reports.
- C. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating sliding aluminum-framed glass doors that meet or exceed performance requirements indicated and of documenting this performance by inclusion in lists and by labels, test reports, and calculations.

1.6 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of sliding aluminum-framed glass doors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. Sliding Door: Three years from date of Substantial Completion.
 - b. Aluminum Finish: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Basis of Design: Aluminum sliding doors by PK30 System LLC (Contact: mamaral@pk30system.com).
- B. Substitutions: Refer to Section 012500 – Substitution Procedures.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Deflection of Framing Members Supporting Glass: Limit lateral deflection to 1/175 of clear span or 3/4 inch, whichever is less, when tested under a uniformly distributed load of 5 lb/sq. ft. according to ASTM E 72.
- C. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

2.3 SLIDING ALUMINUM-FRAMED GLASS DOORS

- A. Frames and Door Panels: Fabricated from aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.
- B. Provide main extrusions of not less than 0.080-inch wall thickness. Provide the following stile/rail/mullion dimensions, unless otherwise indicated.
 - 1. Horizontal rails: 2.3125-inch high by 1.750-inch wide.
 - 2. Vertical stiles: 0.9375-inch high by 1.750-inch wide.
 - 3. Mullions: 0.625-inch high by 1.750-inch wide.
 - 4. Provide extruded glazing stops and other applied trim extrusions with minimum wall thickness of 0.050-inch.
- C. Overhead Track: Provide extruded-aluminum overhead recessed track of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated; with manufacturer's standard finish.
- D. Fasteners: 18/8 stainless steel.

2.4 GLAZING

- A. Glass and Glazing: Manufacturer's standard glazing system.
- B. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 - 1. Thickness: ½ inch.
 - 2. Refer to Section 088000 – Glazing for additional requirements.
 - 3. Gaskets: Use manufacturer's standard extruded clear silicone or black neoprene durometer 70 glazing gaskets.

2.5 HARDWARE

- A. General: Provide manufacturer's standard heavy-duty hardware, fabricated from a corrosion-resistant material compatible with aluminum complying with AAMA 907 and designed to smoothly operate, tightly close, and securely lock sliding aluminum-framed glass doors.
- B. Operating hardware for Sliding Doors: 150/B sliding door hardware by Hawa.
- C. Door Pulls: Rockwood RM3301-BTB-72OA-66CTC-13HD-FBPC back-to-back glass mounted bar pulls, no locks.

2.6 ACCESSORIES

- A. Anchors, Clips, and Accessories: Provide anchors, clips, and accessories of aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron for sliding aluminum-framed glass doors, complying with ASTM B456 or ASTM B633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

2.7 FABRICATION

- A. Fabricate sliding aluminum-framed glass doors in sizes indicated. Include a complete system for assembling components and anchoring doors.
- B. Provide shop assembled panels with hardware and accessories required for a complete assembly. Provide concealed fastening devices and pressure-fit components that will not damage ceiling or floor coverings. Fabricate panels with continuous light-and-sound seals at floor, ceiling, and other locations where panels abut fixed construction.
 - 1. Factory prepare interior aluminum frames to receive templated mortised hardware; include cutouts, reinforcements, mortising, drilling, and tapping.
 - 2. Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame.
 - 3. Locate removable stops on the inside of spaces accessed by keyed doors.
 - 4. Fabricate components to allow secure installation without exposed fasteners.
 - 5. Bottom guide Channel: Provide lower guide channel for sliding doors with a travel distance that is greater than the door width.
- C. Factory-Glazed Fabrication: Glaze sliding aluminum-framed glass doors in the factory where practical and possible for applications indicated. Comply with requirements in Section 088000 "Glazing" and with AAMA/WDMA/CSA 101/I.S.2/A440.

2.8 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing doors, hardware, accessories, and other components.
- B. Install sliding aluminum-framed glass doors, sidelights and transom level, plumb, square, true to line, without distortion, without warp or rack of frames and panels, and without impeding thermal movement; anchored securely in place to structural support; and in proper relation to wall flashing, vapor retarders, air barriers, water/weather barriers, and other adjacent construction.
- C. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.2 ADJUSTING, CLEANING, AND PROTECTION

- A. Lubricate hardware and moving parts.
- B. Adjust operating panels to provide a tight fit at contact points for smooth operation, without binding. Adjust hardware for proper alignment, smooth operation, and proper latching without unnecessary force or excessive clearance.
- C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- D. Protect sliding aluminum-framed glass door surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances contact sliding aluminum-framed glass door surfaces, remove contaminants immediately according to manufacturer's written instructions.
- E. Refinish or replace sliding aluminum-framed glass doors with damaged finishes.

END OF SECTION 083213

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum-framed storefront systems.
2. Aluminum-framed entrance door systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
3. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
4. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
5. Environmental Product Declaration: For each product.
6. Health Product Declaration: For each product.
7. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.

3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
4. Include point-to-point wiring diagrams showing the following:
 - a. Power requirements for each electrically operated door hardware.
 - b. Location and types of switches, signal device, conduit sizes, and number and size of wires.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch (300-mm) lengths of full-size components and showing details of the following:
 1. Joinery, including concealed welds.
 2. Anchorage.
 3. Expansion provisions.
 4. Glazing.
 5. Flashing and drainage.
- F. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
- G. Delegated Design Submittal: For aluminum-framed entrances and storefronts including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

- A. Certificates:
 1. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.
 - a. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.
- B. Test and Evaluation Reports:
 1. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by qualified testing agency.
- C. Source Quality-Control Submittals:
 1. Source quality-control reports.
- D. Field Quality-Control Submittals:

- E. Delegated design engineer qualifications.
- F. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For aluminum-framed entrances and storefronts.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Installers: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors.
2. Delegated Design Engineer: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of the type indicated.

- B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

- a. Structural failures, including, but not limited to, excessive deflection.
- b. Noise or vibration created by wind and thermal and structural movements.
- c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- d. Water penetration through fixed glazing and framing areas.
- e. Failure of operating components.

2. Warranty Period: 10 years from date of Substantial Completion.

- B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Warranty Period: 20 years from date of Substantial Completion.
- C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D 4214.
 - c. Cracking, peeling, or chipping.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.
- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- C. Structural Loads:
1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: As indicated on Drawings.
- D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:
1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to **13 feet 6 inches (4.1 m)** and to 1/240 of clear span plus **1/4 inch (6.35 mm)** for spans greater than **13 feet 6 inches (4.1 m)**.
 2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than **1/8 inch (3.2 mm)**.
 - a. Operable Units: Provide a minimum **1/16-inch (1.6-mm)** clearance between framing members and operable units.
 3. Cantilever Deflection: Limited to 2L/175 at unsupported cantilevers.
- E. Structural: Test in accordance with ASTM E330/E330M as follows:
1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than **6.24 lbf/sq. ft. (300 Pa)**.
- G. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than **6.24 lbf/sq. ft. (300 Pa)**.
 2. Maximum Water Leakage: In accordance with AAMA 501.1. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.
- H. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:
1. Thermal Transmittance (U-factor):
 - a. Fixed Glazing and Framing Areas: U-factor for the system of not more than **0.41 Btu/sq. ft. x h x deg F (2.33 W/sq. m x K)** as determined in accordance with NFRC 100.
 - b. Entrance Doors: U-factor of not more than **0.68 Btu/sq. ft. x h x deg F (3.86 W/sq. m x K)** as determined in accordance with NFRC 100.
 2. Solar Heat-Gain Coefficient (SHGC):
 - a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.35 as determined in accordance with NFRC 200.
 - b. Entrance Doors: SHGC of not more than 0.25 as determined in accordance with NFRC 200.
 3. Air Leakage:
 - a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than **0.06 cfm/sq. ft. (0.30 L/s per sq. m)** at a static-air-pressure differential of **1.57 lbf/sq. ft. (75 Pa)** when tested in accordance with ASTM E283.
 - b. Entrance Doors: Air leakage of not more than **1.0 cfm/sq. ft. (5.08 L/s per sq. m)** at a static-air-pressure differential of **1.57 lbf/sq. ft. (75 Pa)**.
 4. Condensation Resistance Factor (CRF):
 - a. Fixed Glazing and Framing Areas: CRF for the system of not less than 70 as determined in accordance with AAMA 1503.
 - b. Entrance Doors: CRF of not less than 68 as determined in accordance with AAMA 1503.
- I. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows.
1. Outdoor-Indoor Transmission Class: Minimum 34.
- J. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
1. Temperature Change: **120 deg F (67 deg C)**, ambient; **180 deg F (100 deg C)**, material surfaces.

2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
 - b. Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).
 - c. Interior Ambient-Air Temperature: 75 deg F (24 deg C).

2.3 STOREFRONT SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer Company, Inc.; Arconic Corporation; 451T, and 600T where noted, or a comparable product by one of the following:
 1. EFCO Corporation.
 2. Tubelite Inc.
 3. U.S. Aluminum; C.R. Laurence Co., Inc.; CRH Americas, Inc.
 4. YKK AP America Inc.
- B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 1. Exterior Framing Construction: Thermally broken <Insert description>.
 2. Glazing System: Retained mechanically with gaskets on four sides.
 3. Glazing Plane: Front.
 4. Finish: Clear anodic finish.
 5. Fabrication Method: Field-fabricated stick system.
 6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 7. Steel Reinforcement: As required by manufacturer.
- C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.4 ENTRANCE DOOR SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer Company, Inc.; Arconic Corporation; Insulpour 500T or a comparable product by one of the following:
 1. EFCO Corporation.
 2. Tubelite Inc.
 3. U.S. Aluminum; C.R. Laurence Co., Inc.; CRH Americas, Inc.
 4. YKK AP America Inc.

- B. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.
 - 1. Door Construction: 2- to 2-1/4-inch (50.8- to 57.2-mm) overall thickness, with minimum 0.125-inch- (3.2-mm-) thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 - a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
 - 2. Door Design: Wide stile; 5-inch (127-mm) nominal width.
 - 3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.
 - a. Provide nonremovable glazing stops on outside of door.
 - 4. Finish: Match adjacent storefront framing finish.

2.5 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 087100 "Door Hardware."
- B. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule for each entrance door, to comply with requirements in this Section.

2.6 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.
 - 1. Verify sealant has a VOC content of 250 g/L or less.
 - 2. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- D. Weatherseal Sealants: ASTM C920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed storefront manufacturers for this use.
 - 1. Color: Match structural sealant.

2.7 MATERIALS

- A. Sheet and Plate: **ASTM B209** (ASTM B209M).
- B. Extruded Bars, Rods, Profiles, and Tubes: **ASTM B221** (ASTM B221M).
- C. Structural Profiles: ASTM B308/B308M.
- D. Steel Reinforcement:
 - 1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
 - 2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
 - 3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.
- E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.
- F. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- G. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [25] [50] <Insert value> percent.
- H. Regional Materials: Manufacture products within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

2.8 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- B. Anchors: Three-way adjustable anchors with minimum adjustment of **1 inch (25.4 mm)** that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

- D. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for **30-mil (0.762-mm)** thickness per coat.
- E. Rigid PVC filler.

2.9 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from **[exterior] [interior] [interior for vision glass and exterior for spandrel glazing or metal panels]**.
 - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Storefront Framing: Fabricate components for assembly using shear-block system.
- F. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 - 1. At interior and exterior doors, provide compression weather stripping at fixed stops.
- G. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
 - 1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
 - 2. At exterior doors, provide weather sweeps applied to door bottoms.
- H. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- I. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.10 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions.
- B. Do not install damaged components.
- C. Fit joints to produce hairline joints free of burrs and distortion.
- D. Rigidly secure nonmovement joints.
- E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Seal perimeter and other joints watertight unless otherwise indicated.
- G. Metal Protection:
 - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
 - 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.
- I. Install joint filler behind sealant as recommended by sealant manufacturer.
- J. Install components plumb and true in alignment with established lines and grades.

3.3 INSTALLATION OF GLAZING

- A. Install glazing as specified in Section 088000 "Glazing."

3.4 INSTALLATION OF ALUMINUM-FRAMED ENTRANCE DOORS

- A. Install entrance doors to produce smooth operation and tight fit at contact points.
 - 1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
 - 2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware in accordance with entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.5 ERECTION TOLERANCES

- A. Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
 - 1. Plumb: **1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).**
 - 2. Level: **1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).**
 - 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to **1/2 inch (12.7 mm)** wide, limit offset from true alignment to **1/16 inch (1.6 mm)**.
 - b. Where surfaces are separated by reveal or protruding element from **1/2 to 1 inch (12.7 to 25.4 mm)** wide, limit offset from true alignment to **1/8 inch (3.2 mm)**.
 - c. Where surfaces are separated by reveal or protruding element of **1 inch (25.4 mm)** wide or more, limit offset from true alignment to **1/4 inch (6 mm)**.
 - 4. Location: Limit variation from plane to **1/8 inch in 12 feet (3.2 mm in 3.6 m); 1/2 inch (12.7 mm)** over total length.

END OF SECTION 084113

SECTION 087111 - DOOR HARDWARE (DESCRIPTIVE SPECIFICATION)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mechanical door hardware for the following:
 - a. Swinging doors.
 - b. Sliding doors.
 - c. Folding doors.
2. Cylinders for door hardware specified in other Sections.
3. Electrified door hardware.

B. Related Requirements:

1. **[Section 064113 "Wood-Veneer-Faced Architectural Cabinets"] [and] [Section 064116 "Plastic-Laminate-Clad Architectural Cabinets"]** for cabinet door hardware provided with cabinets.
2. Section 081113 "Hollow Metal Doors and Frames" **[for astragals provided as part of labeled fire-rated assemblies] [and] [for door silencers provided as part of hollow-metal frames]**.
3. Section 081119 "Stainless-Steel Doors and Frames" **[for astragals provided as part of labeled fire-rated assemblies] [and] [for door silencers provided as part of stainless steel frames]**.
4. Section 081173 "Sliding Metal Fire Doors" for door and track preparation, reinforcement, and motorized operators provided as part of automatic-closing assemblies.
5. Section 081213 "Hollow Metal Frames" **[for astragals provided as part of labeled fire-rated assemblies] [and] [for door silencers provided as part of hollow-metal frames]**.
6. Section 081216 "Aluminum Frames" for door silencers provided as part of aluminum frames.
7. Section 081316.13 "Aluminum Terrace Doors" for entrance door hardware, **[except] [including]** cylinders.
8. Section 081416 "Flush Wood Doors" for **[astragals] [and] [integral intumescent seals]** provided as part of labeled fire-rated assemblies.
9. Section 081433 "Stile and Rail Wood Doors" for **[astragals] [and] [integral intumescent seals]** provided as part of labeled fire-rated assemblies.
10. Section 083113 "Access Doors and Frames" for access door hardware, **[except] [including]** cylinders.
11. Section 083323 "Overhead Coiling Doors" for door hardware provided as part of overhead coiling door assemblies.
12. Section 083326 "Overhead Coiling Grilles" for door hardware provided as part of overhead coiling grille assemblies.

13. [Section 083473.13 "Metal Sound Control Door Assemblies"] [and] [Section 083473.16 "Wood Sound Control Door Assemblies"] for hinges and gasketing provided as part of sound-rated door assemblies.
14. Section 083513 "Folding Doors" for pulls, latches, hinges, guides, and pivots provided as part of the folding door package.
15. Section 084113 "Aluminum-Framed Entrances and Storefronts" for entrance door hardware, [except] [including] cylinders.
16. Section 084126 "All-Glass Entrances and Storefronts" for entrance door hardware, [except] [including] cylinders.
17. Section 084229.13 "Folding Automatic Entrances" for entrance door hardware, [except] [including] cylinders.
18. Section 084229.23 "Sliding Automatic Entrances" for entrance door hardware, [except] [including] cylinders.
19. Section 084229.33 "Swinging Automatic Entrances" for entrance door hardware, [except] [including] cylinders.
20. Section 084243 "Intensive Care Unit/Critical Care Unit (ICU/CCU) Entrances" for entrance door hardware, [except] [including] cylinders.
21. Section 087113 "Power Door Operators" for low-energy power operators and low-energy power-assist operators.
22. Section 102213 "Wire Mesh Partitions" for door hardware for doors in wire mesh partitions, [except] [including] cylinders.
23. Section 102600 "Wall and Door Protection" for plastic door protection units that match wall protection units.
24. Section 119812 "Detention Doors and Frames" for door silencers provided as part of detention frames.
25. Section 119814 "Detention Door Hardware" for hardware for detention doors.
26. Section 133419 "Metal Building Systems" for door hardware, [except] [including] cylinders.
27. Section 134900 "Radiation Protection" for lead-lined astragals provided as part of labeled fire-rated assemblies.
28. Section 283100 "Intrusion Detection" for detection devices installed at door openings and provided as part of an intrusion-detection system.
29. Section 284621.11 "Addressable Fire-Alarm Systems" for connections to building fire-alarm system.
30. Section 284621.13 "Conventional Fire-Alarm Systems" for connections to building fire-alarm system.

1.2 ALLOWANCES

- A. Door hardware is part of [Door Hardware Allowance] <Insert allowance>.

1.3 COORDINATION

- A. Floor-Recessed Door Hardware: Coordinate layout and installation with floor construction.
 1. Cast anchoring inserts into concrete.

- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
- E. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.
 - 1. Conference participants shall include Installer's Architectural Hardware Consultant[**and Owner's security consultant**].
- B. Keying Conference: Conduct conference at [**Project site**] <**Insert location**>.
 - 1. Conference participants shall include Installer's Architectural Hardware Consultant[**and Owner's security consultant**].
 - 2. Incorporate conference decisions into keying schedule after reviewing door hardware keying system including, but not limited to, the following:
 - a. Flow of traffic and degree of security required.
 - b. Preliminary key system schematic diagram.
 - c. Requirements for key control system.
 - d. Requirements for access control.
 - e. Address for delivery of keys.
 - f. <**Insert requirements to suit Project**>.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For electrified door hardware.
 - 1. Include diagrams for power, signal, and control wiring.
 - 2. Include details of interface of electrified door hardware and building safety and security systems.

- C. Samples: For each exposed product in each finish specified, in manufacturer's standard size.
 - 1. Tag Samples with full product description to coordinate Samples with door hardware schedule.
- D. Samples for Initial Selection: For each type of exposed finish.
- E. Samples for Verification: For each type of exposed product, in each finish specified.
 - 1. Sample Size: Full-size units or minimum **2-by-4-inch (51-by-102-mm)** Samples for sheet and **4-inch (102-mm)** long Samples for other products.
 - a. Full-size Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.
 - 2. Tag Samples with full product description to coordinate Samples with door hardware schedule.
- F. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Submittal Sequence: Submit door hardware schedule **[after]** **[or]** **[concurrent with]** submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
 - 2. Format: Use same scheduling sequence and format **[and use same door numbers]** as in door hardware schedule in the Contract Documents.
 - 3. Content: Include the following information:
 - a. Identification number, location, hand, fire rating, size, and material of each door and frame.
 - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.
 - e. Fastenings and other installation information.
 - f. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
 - g. Mounting locations for door hardware.
 - h. List of related door devices specified in other Sections for each door and frame.
- G. Keying Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **[Installer]** **[and]** **[Architectural Hardware Consultant]**.
- B. Product Certificates: For each type of electrified door hardware.
 - 1. Certify that door hardware for use on each type and size of labeled fire-rated doors complies with listed fire-rated door assemblies.
- C. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.
- B. Schedules: Final **[door hardware]** **[and]** **[keying]** schedule.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Door Hardware: **<Insert detailed descriptions and specific numbers of units>**.
 - 2. Electrical Parts: **<Insert detailed descriptions and specific numbers of units>**.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware and keying.
 - 1. Warehousing Facilities: In Project's vicinity.
 - 2. Scheduling Responsibility: Preparation of door hardware and keying schedule.
 - 3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as an **[Architectural Hardware Consultant (AHC)]** **[Architectural Hardware Consultant (AHC)]**

and an Electrified Hardware Consultant (EHC)] [Architectural Openings Consultant (AOC)].

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.
- D. Deliver keys[**and permanent cores**] to Owner by registered mail or overnight package service.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of doors and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: [**Three**] <Insert number> years from date of Substantial Completion unless otherwise indicated below:
 - a. [**Electromagnetic**] [**and**] [**Delayed-Egress**] Locks: [**Five**] <Insert number> years from date of Substantial Completion.
 - b. Exit Devices: [**Two**] <Insert number> years from date of Substantial Completion.
 - c. Manual Closers: [**10**] <Insert number> years from date of Substantial Completion.
 - d. Concealed Floor Closers: [**Five**] [**10**] [**25**] <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of door hardware from single manufacturer.
 - 1. Provide electrified door hardware from same manufacturer as mechanical door hardware unless otherwise indicated. Manufacturers that perform electrical modifications and that

are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
- B. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that complies with requirements of assemblies tested in accordance with UL 1784 and installed in compliance with NFPA 105.
 - 1. Air Leakage Rate: Maximum air leakage of [**0.3 cfm/sq. ft. (3 cu. m per minute/sq. m)**] **<Insert rate>** at the tested pressure differential of [**0.3-inch wg (75 Pa)**] **<Insert value>** of water.
- C. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Means of Egress Doors: Latches do not require more than **15 lbf (67 N)** to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- E. Accessibility Requirements: For door hardware on doors in an accessible route, comply with **[the USDOJ's "2010 ADA Standards for Accessible Design"] [the DOT's "ADA Standards for Transportation Facilities"] [the ABA standards of the Federal agency having jurisdiction] [ICC A117.1] [HUD's "Fair Housing Accessibility Guidelines"] [and] <Insert regulation>**.
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than **5 lbf (22.2 N)**.
 - 2. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: **5 lbf (22.2 N)** applied perpendicular to door.
 - b. Sliding or Folding Doors: **5 lbf (22.2 N)** applied parallel to door at latch.
 - c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 - 3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than **1/2 inch (13 mm)** high.
 - 4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.
 - 5. Adjust spring hinges so that, from an open position of 70 degrees, the door will take at least 1.5 seconds to move to the closed position.

2.3 HINGES

- A. Hinges: BHMA A156.1. [**Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.**]
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Antifriction-Bearing Hinges:
1. Mounting: [**Full mortise (butts)**] [**Half mortise**] [**Full surface**] [**Half surface**].
 2. Bearing Material: [**Manufacturer's standard antifriction bearing**] [**Ball bearing**] < **Insert material** >.
 3. [**Grade 1 (heavy weight)**] [**Grade 2 (standard weight)**].
 4. Base and Pin Metal:
 - a. Exterior Hinges: [**Stainless steel with stainless steel pin**] [**Brass with stainless steel pin body and brass protruding heads**].
 - b. Interior Hinges: [**Brass with stainless steel pin body and brass protruding heads**] [**Steel with steel pin**] [**Stainless steel with stainless steel pin**].
 - c. Hinges for Fire-Rated Assemblies: [**Steel with steel pin**] [**Stainless steel with stainless steel pin**].
 5. Pins: [**Non-rising loose unless otherwise indicated**] [**Maximum security**] [**Nonremovable**].
 - a. Outswinging Exterior Doors: [**Maximum security**] [**Nonremovable**].
 - b. Outswinging Corridor Doors with Locks: [**Maximum security**] [**Nonremovable**].
 6. Tips: [**Flat button**] [**Hospital**] [**Oval**] [**Ball**] [**Steeple**] [**Urn**] [**Acorn**].
 7. Corners: [**Square**] [**5/32-inch (4-mm) radius**] [**1/4-inch (6-mm) radius**] [**5/8-inch (16-mm) radius**].
 8. Features: [**Raised barrel**] [**Reverse safety stud**] [**Safety stud**] < **Insert special swaging requirements or other features** >.
- C. Electrified Antifriction-Bearing Hinges: Full-mortise mounting.
1. Bearing Material: [**Manufacturer's standard antifriction bearing**] [**Ball bearing**] < **Insert material** >.
 2. [**Grade 1 (heavy weight)**] [**Grade 2 (standard weight)**].
 3. Base and Pin Metal:
 - a. Exterior Hinges: [**Stainless steel with stainless steel pin**] [**Brass with stainless steel pin body and brass protruding heads**].
 - b. Interior Hinges: [**Brass with stainless steel pin body and brass protruding heads**] [**Steel with steel pin**] [**Stainless steel with stainless steel pin**].
 - c. Hinges for Fire-Rated Assemblies: [**Steel with steel pin**] [**Stainless steel with stainless steel pin**].
 4. Pins: [**Non-rising loose unless otherwise indicated**] [**Maximum security**] [**Nonremovable**].

- a. Outswinging Exterior Doors: [**Maximum security**] [**Nonremovable**].
 - b. Outswinging Corridor Doors with Locks: [**Maximum security**] [**Nonremovable**].
5. Tips: [**Flat button**] [**Hospital**] [**Oval**] [**Ball**] [**Steeple**] [**Urn**] [**Acorn**].
 6. Corners: Square.
 7. Features: [**Raised barrel**] [**Reverse safety stud**] [**Safety stud**] <Insert special swaging requirements or other features>.
 8. Electric Feature: [**Concealed electric through wires**] [**Concealed electric through wires with monitor**] [**Concealed electric monitor**] [**Concealed air transfer**] [**Concealed switch**] [**Exposed electric switch**] [**Exposed electric contacts**] <Insert feature>.
- D. Plain-Bearing Hinges: Grade 3 (standard weight).
1. Mounting: [**Full mortise (butts)**] [**Half mortise**] [**Full surface**] [**Half surface**].
 2. Base and Pin Metal: [**Brass with stainless steel pin body and brass protruding heads**] [**Steel with steel pin**].
 3. Pins: [**Non-rising loose unless otherwise indicated**] [**Maximum security**] [**Nonremovable**].
 - a. Outswinging Corridor Doors with Locks: [**Maximum security**] [**Nonremovable**].
 4. Tips: [**Flat button**] [**Hospital**] [**Oval**] [**Ball**] [**Steeple**] [**Urn**] [**Acorn**].
 5. Corners: [**Square**] [**5/32-inch (4-mm) radius**] [**1/4-inch (6-mm) radius**] [**5/8-inch (16-mm) radius**].
 6. Features: [**Raised barrel**] <Insert special swaging requirements or other features>.
- E. Swing-Clear Hinges: Reversible.
1. Mounting: [**Full mortise (butts)**] [**Half mortise**] [**Full surface**] [**Half surface**].
 2. Bearing and Grade: [**Antifriction bearing, Grade 1 (heavy weight)**] [**Antifriction bearing, Grade 2 (standard weight)**] [**Plain bearing, Grade 3 (standard weight)**].
 3. Base Metal: [**Wrought brass or bronze**] [**Stainless steel**] [**Wrought, forged, or cast steel, or malleable iron**].
 4. Pins: [**Non-rising loose unless otherwise indicated**] [**Maximum security**] [**Nonremovable**].
 - a. Outswinging Exterior Doors: [**Maximum security**] [**Nonremovable**].
 - b. Outswinging Corridor Doors with Locks: [**Maximum security**] [**Nonremovable**].
 5. Tips: [**Flat button**] [**Hospital**].
 6. Corners: [**Square**] [**5/32-inch (4-mm) radius**] [**1/4-inch (6-mm) radius**] [**5/8-inch (16-mm) radius**].
 7. Features: [**Raised barrel**] [**Reverse safety stud**] [**Safety stud**] <Insert special swaging requirements or other features>.
- F. Slip-in-Type Hinges: Full-mortise mounting.
1. Bearing and Grade: [**Antifriction, Grade 1 (heavy weight)**] [**Antifriction, Grade 2 (standard weight)**] [**Plain, Grade 3 (standard weight)**].

2. Base Metal: [**Wrought brass or bronze**] [**Stainless steel**] [**Wrought, forged, or cast steel, or malleable iron**].
3. Swaging: [**5/16-inch (7.9-mm)** swaging] [**3/16-inch (4.8-mm)** swaging, handed].

G. Anchor Hinge Set: Grade 1 (heavy weight); consisting of one anchor hinge plus two full-mortise hinges; antifriction bearing; handed; nonremovable pins; flat-button tips.

1. Base Metal: [**Wrought brass or bronze**] [**Stainless steel**] [**Wrought, forged, or cast steel, or malleable iron**].
2. Electric Feature for Center Hinge: [**Concealed electric through wires**] [**Concealed electric switch**] <Insert feature>.

2.4 SELF-CLOSING HINGES AND PIVOTS

A. Self-Closing Hinges and Pivots: BHMA A156.17.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

B. Spring Hinges: [**Grade 1**] [**Grade 2**]; wrought steel, with torsion spring.

1. Type: [**Single**] [**Double**] acting.
2. Mounting: [**Full mortise (butts)**] [**Half mortise**] [**Full surface**] [**Half surface**].

C. Horizontal-Spring Pivot Sets: Grade 3; double acting; non-handed; consisting of wrought steel bottom pivot hinge with antifriction bearing and of nylon top pivot and socket.

1. Type: [**Hold open**] [**Non-hold open**].
2. Tension: [**Adjustable**] [**Fixed**].
3. Bottom Pivot Trim: [**Steel**] [**Brass**].
4. Bottom Plate: For bottom hinge attachment to [**floor**] [**jamb**].

D. Gate-Spring Pivot Sets: Grade 1; double acting; non-handed; consisting of bottom pivot with door and jamb bracket and of top pivot assembly with jamb bracket.

1. Mounting: [**Mortise**] [**Surface**].
2. Tension: [**Adjustable**] [**Fixed**].
3. Base Metal: [**Cast, forged, or extruded brass or bronze**] [**Malleable iron**].

E. Gravity Pivot Sets: Grade 3; double acting; surface mounting; non-handed; consisting of bottom pivot with door and jamb bracket and of top pivot assembly with jamb bracket.

1. Tension: [**Adjustable**] [**Fixed**].
2. Base Metal: [**Wrought brass or bronze**] [**Steel**].

2.5 CENTER-HUNG AND OFFSET PIVOTS

A. Center-Hung and Offset Pivots: BHMA A156.4.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Center-Hung Pivot Sets: Grade 1.
1. Top Pivots: Walking-beam type with retractable pin and oil-impregnated bronze bearing; mortised into door and frame.
 2. Bottom Pivots: [**Surface floor mounted,**] [**Recessed in floor in cement case,**] [**Mortised into jamb,**] and mortised into door.
 - a. Bearing: [**Thrust ball**] [**Needle**].
 3. Base Metal: [**Brass**] [**Bronze**] [**Steel**].
- C. Offset Pivot Sets: [**Grade 1**] [**Grade 2**].
1. Offset: [**3/4 inch (19 mm)**] [**1-1/2 inches (38 mm)**].
 2. Top Pivot: [**Full-mortise**] [**Half-surface**] [**Full-surface**] mounting; walking-beam type with retractable pin and oil-impregnated bronze bearing.
 - a. Knuckle: [**Standard**] [**Asylum type**].
 - b. Feature: [**With screw holes designed to straddle lead in center of lead-lined door**] **<Insert feature>**.
 3. Bottom Pivot: [**Surface floor mounted,**] [**Recessed in floor in cement case,**] [**Mortised into jamb,**] and mortised into door; with [**thrust ball**] [**needle**] bearing.
 4. Base Metal: [**Brass**] [**Bronze**] [**Stainless steel**] [**Steel**].
- D. Offset Intermediate Pivots: Grade 1; for use with offset pivot sets; with oil-impregnated bronze bearings.
1. Mounting: [**Full mortise, 3/4-inch (19-mm) offset**] [**Full mortise, 1-1/2-inch (38-mm) offset**] [**Half mortise**] [**Half surface**] [**Full surface**].
 2. Knuckle: [**Standard**] [**Asylum type**].
 3. Feature: [**With screw holes designed to straddle lead in center of lead-lined door**] **<Insert feature>**.
 4. Electric Feature: [**Concealed monitoring**] [**Concealed power transfer**] [**Concealed power transfer for use with electrical panic devices and locks**] **<Insert feature>**.
 5. Base Metal: [**Brass**] [**Bronze**] [**Stainless steel**] [**Steel**].
- E. Pocket Pivots: Grade 1; full-mortise mounting; non-handed; allows door to nest in pocket with door surface flush with corridor wall when open; maximum 90-degree swing.
1. Base Metal: [**Bronze**] [**Stainless steel**] [**Steel**].
 2. Electric Feature: [**Concealed power transfer in one hinge per door**] **<Insert feature>**.

2.6 CONTINUOUS HINGES

- A. Continuous Hinges: BHMA A156.26; minimum **0.120-inch- (3.0-mm-)** thick, hinge leaves with minimum overall width of **4 inches (102 mm)**; fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.
- B. Pin-and-Barrel-Type Hinges:
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Grade: [**1-150**] [**1-300**] [**1-600**] [**2-150**] [**2-300**] [**2-600**] [**3-150**] [**3-300**] **<Insert grade>**.
 3. Exterior Hinges: Stainless steel.
 4. Interior Hinges: [**Stainless steel**] [**Steel**] [**Aluminum**].
 5. Hinges for Fire-Rated Assemblies: [**Stainless steel with steel fire pins to hold fire-rated doors in place if required by tested listing**] [**Steel**].
 6. Type: [**Concealed leaf**] [**Swing clear**] [**Full surface with removable continuous caps over fasteners**] [**Half mortise, concealed door leaf and with removable continuous cap over fasteners on jamb leaf**] [**Half surface, concealed jamb leaf and with removable continuous cap over fasteners on door leaf**].
 7. Electric Feature: [**Electric monitoring switch**] [**Electric through wires and monitor**] [**Electric through wires**] [**Concealed power transfer**] [**Exposed power transfer contact switch**] **<Insert feature>**.
- C. Continuous, Gear-Type Hinges: Extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Grade: [**1-150**] [**1-300**] [**1-600**] [**2-150**] [**2-300**] [**2-600**] [**3-150**] [**3-300**] **<Insert grade>**.
 3. Hinges for Fire-Rated Assemblies: With steel fire pins to hold fire-rated doors in place if required by tested listing.
 4. Mounting: [**Concealed leaf**] [**Swing clear**] [**Full surface, with removable continuous caps over fasteners**] [**Half surface, concealed jamb leaf and with removable continuous cap over fasteners on door leaf**].
 5. Electric Feature: [**Electric monitor**] [**Electric through wires and monitor**] [**Electric through wires**] [**Electric power transfer**] [**Exposed switch**] [**Exposed contact**] [**Removable electric through wires**] **<Insert feature>**.

2.7 CONCEALED HINGES

- A. Concealed Hinges: Fully concealed within mortises in the door edge and frame and allowing door to swing open 180 degrees.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Electric Feature: [**Electric through wires**] [**Electric power transfer**] **<Insert feature>**.

2.8 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: As indicated in door hardware schedule.

- B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
1. Bored Locks: Minimum **1/2-inch (13-mm)** latchbolt throw.
 2. Mortise Locks: Minimum **3/4-inch (19-mm)** latchbolt throw.
 3. Deadbolts: Minimum [**1-inch (25-mm)**] [**1.25-inch (32-mm)**] **<Insert dimension>** bolt throw.
- C. Lock Backset: **2-3/4 inches (70 mm)** unless otherwise indicated.
- D. Lock Trim:
1. Description: [**As indicated on Drawings**] **<Insert description or manufacturer's design designation>**.
 2. Levers: [**Wrought**] [**Forged**] [**Cast**].
 - a. **<Insert model number and description>**.
 - b. Construction: [**Solid**] [**Tube**] [**Freewheeling vandal resistant**] [**Breakaway vandal resistant**].
 3. Escutcheons (Roses): [**Wrought**] [**Forged**] [**Cast**].
 4. Dummy Trim: Match lever lock trim and escutcheons.
- E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 3. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
 4. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.
- F. Bored Locks: BHMA A156.2; [**Grade 1**] [**Grade 2**]; Series 4000.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- G. Mortise Locks: BHMA A156.13; [**Operational Grade 1**] [**Security Grade 1**] [**Operational Grade 2**] [**Security Grade 2**]; stamped steel case with steel or brass parts; Series 1000.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- H. Interconnected Locks: BHMA A156.12; [**Grade 1**] [**Grade 2**]; Series 5000.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- I. Roller Latches: BHMA A156.16; Grade 1; rolling plunger that engages socket or catch, with adjustable roller projection.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Material: [**Brass**] [**Bronze**].
3. Mounting: [**Surface**] [**Mortise**].

J. Push-Pull Latches: [**Bored, BHMA A156.2; Series 4000**] [**Mortise, BHMA A156.13**]; with paddle handles that retract latchbolt; capable of being mounted vertically or horizontally.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. [**Grade 1**] [**Grade 2**].
3. Lever and Escutcheon Material: [**Brass**] [**Bronze**] [**Stainless steel**] [**Aluminum**].
4. Lettering: Engrave with the words "Pull" and "Push."
5. Lead Lining: [**0.047 inch (1.2 mm)**] **<Insert dimension>** thick for escutcheon plate.

2.9 AUXILIARY LOCKS

A. Bored Auxiliary Locks: BHMA A156.36: [**Grade 1**] [**Grade 2**]; with strike that suits frame.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Backset: [**2-3/8 inches (60 mm)**] [**2-3/4 inches (70 mm)**].
3. Material: [**Aluminum**] [**Brass**] [**Bronze**] [**Stainless steel**] [**Zinc alloy**].
4. Deadlatches: Deadlocking latchbolt operated by [**key either side**] [**key outside and turn inside**] [**turn inside with no cylinder**].
5. Deadlocks: Deadbolt operated by [**key either side**] [**key outside and turn inside**] [**turn inside with no cylinder**] [**key outside, no trim inside**].

B. Mortise Auxiliary Locks: BHMA A156.36; [**Grade 1**] [**Grade 2**]; with strike that suits frame.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Backset: [**2-3/4 inches (70 mm)**] **<Insert dimension>**.
3. Material: [**Aluminum**] [**Brass**] [**Bronze**] [**Stainless steel**] [**Zinc alloy**].
4. Deadlocks: Deadbolt operated by key [**either side**] [**outside and turn inside**] [**one side**].
5. Deadlatches: Latchbolt and auxiliary deadlatch operated by key [**either side**] [**outside and turn inside**].
6. Deadlocks for Sliding Doors: Expanding- or interlocking-type deadbolt operated by key [**either side**] [**outside and turn inside**] [**one side**].
7. Deadlatches for Sliding Doors: Hook-type latchbolt operated by key [**either side**] [**outside and handle inside**].

C. Narrow Stile Auxiliary Locks: BHMA A156.36; [**Grade 1**] [**Grade 2**]; with strike that suits frame.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Backset: [**0.98 inch (25 mm)**] [**1.125 inches (29 mm)**] [**1.25 inches (32 mm)**] [**1.5 inches (38 mm)**] [**1.75 inches (44 mm)**] [**2 inches (51 mm)**] [**2.25 inches (57 mm)**] [**2.5 inches (64 mm)**] **<Insert dimension>**.
3. Strike: [**Flat**] [**Flat with extra-long lip**] [**Radius**] [**Radius with weatherstrip**] [**Bevel**].
4. Case Material: [**Steel**] [**Stainless steel**].
5. Armored Front and Strike Material: [**Aluminum**] [**Brass**] [**Bronze**] [**Stainless steel**].
6. Deadlock: Deadlocking bolt.

- a. Operation: Key [**both sides**] [**outside and operating trim inside**].
 - b. Door Application: [**Swinging**] [**Sliding**] door.
7. Deadlatch: Latchbolt with auxiliary deadlatch operated by key outside and paddle or lever inside; for single swinging doors.
 8. Multipoint Lock: Deadlocking bolt for pairs of swinging doors.
 - a. Operation: Key [**both sides**] [**outside and turn, lever, or knob inside**].
 - b. Type: [**Two**] [**Three**] point.
 9. Latch/Lock: Deadbolt and latchbolt; both operated by key both sides; inside handle operates only latchbolt.
- D. Push-Button Combination Locks: BHMA A156.36; cylindrical; Grade 1; lock opens by entering a one- to five-digit code by pushing correct buttons in correct sequence; automatically relocks when door is closed; with strike that suits frame.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Auxiliary Lock Configuration: [**Deadbolt**] [**Deadlocking latch**] [**Deadlocking rim latch**].
 3. Override: By key cylinder.

2.10 ELECTRIC STRIKES

- A. Electric Strikes: BHMA A156.31; [**Grade 1**] [**Grade 2**]; with faceplate to suit lock and frame.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Material: [**Steel**] [**Stainless steel**] [**Zinc-aluminum alloy**].
 3. Mounting: [**Mortised**] [**Semirim mounted**] [**Rim mounted**].
 4. Fire-Rated Door Assemblies: Use fail-secure electric strikes with fire-rated devices.
 5. Monitoring: [**Mechanical latchbolt**] [**Infrared latchbolt**] [**Mechanical strike**] [**Infrared strike**].
 6. Features: [**Lip extension kit**] [**Open-back strike**] [<Insert feature>](#).

2.11 ELECTROMAGNETIC LOCKS

- A. Electromagnetic Locks: BHMA A156.23; electrically powered; with electromagnet attached to frame and armature plate attached to door; full-exterior or full-interior type, as required by application indicated.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Direct-Hold Type: Lock mounted on [**bottom of header; strike flush mounted on door push side**] [**face of header; strike angle mounted on door pull side**] [**side of jamb; strike flush mounted on door push side**].
 3. Shear Type: Lock [**mounted on face of header; strike angle mounted on door**] [**mortised in header; strike mortised in top of door**] [**mortised in jamb; strike mortised in edge of door**] [**mortised in bottom of door; strike mortised in floor**] [**mortised in floor; strike mortised in bottom of door**].

4. Strength Ranking: [**1500 lbf (6672 N)**] [**1000 lbf (4448 N)**] [**500 lbf (2224 N)**].
5. Inductive Kickback Peak Voltage: Not more than [**53**] [**0**] V.
6. Residual Magnetism: Not more than [**4 lbf (18 N)**] [**0 lbf (0 N)**] to separate door from magnet.
7. Features:
 - a. Magnetic bond sensor.
 - b. Continuous housing for full width of door.
 - c. Continuous housing for full height of door.
 - d. Single LED indicators.
 - e. Double LED indicators.
 - f. Adjustable time delay with automatic relock.
 - g. Integral door position switch.
 - h. **<Insert feature>**.

- B. Delayed-Egress Electromagnetic Locks: BHMA A156.24, electrically powered, with electromagnet attached to frame and armature plate attached to door; depressing push bar for more than three seconds initiates irreversible alarm and adjustable time delay for egress. When integrated with fire alarm, fire alarm voids time delay.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Grade: [**Security grade, activated from secure side of door by initiating device**] [**Movement grade, activated by door movement as initiating device**].

2.12 ELECTROMECHANICAL LOCKS

- A. Electromechanical Locks: BHMA A156.25; [**Grade 1**] [**Grade 2**]; motor or solenoid driven; with strike that suits frame.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Type: [**Bored**] [**Mortise latchbolt**] [**Mortise deadbolt**] [**Mortise deadlocking latchbolt**].

2.13 SELF-CONTAINED ELECTRONIC LOCKS

- A. Self-Contained Electronic Locks: BHMA A156.25, [**bored**] [**mortise**]; with internal, battery-powered, self-contained electronic locks; consisting of complete lockset, motor-driven lock mechanism, and actuating device; enclosed in zinc-dichromate-plated, wrought-steel case, and strike that suits frame. Provide key override, low-battery detection and warning, LED status indicators, and ability to program at the lock.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Actuating Device: [**Digital keypad**] [**Magnetic-stripe card reader**] [**Smart-card reader**] **<Insert device>**.
 - a. Card: [**Manufacturer's standard**] [**0.030-inch- (0.76-mm-) thick PVC or polyester**] [**Custom**].
 - b. Accessory: Card encoder and software.

3. Faceplate Material: [**Wrought brass**] [**Wrought bronze**] [**Stainless steel**].
4. Lock Trim: [**Lever**] [**Knob**] [**Match trim specified for mechanical locks**].
5. Function: [**Latch with**] [**Deadbolt with**] [**Latch without**] [**Deadbolt without**] key.

2.14 EXIT LOCKS AND EXIT ALARMS

A. Exit Locks and Alarms: BHMA A156.29, Grade 1.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

B. Exit Locks: Surface mounted; battery powered, housed in metal case; with manufacturer's standard strike that suits frame; with red-and-white lettering reading "EMERGENCY EXIT PUSH TO OPEN - ALARM WILL SOUND."

1. [**Single-Door**] [**Pairs-of-Door**] Type: Activated by [**arm, push plate, or paddle**] [**horizontal bar**].
2. Features:
 - a. Low-battery alert.
 - b. Outside key control.
 - c. Audible alarm that sounds when unauthorized use of door occurs.
 - d. Silent alarm with remote signal capability for connection to remote indicating panel.
 - e. Strike: [**Surface**] [**Mortise**].
 - f. **<Insert feature>**.

C. Standalone Exit Alarms: [**Surface mounted on door**] [**Mounted separate from door and activated by door movement switch**].

1. Features:
 - a. Low-battery alert.
 - b. Outside key control.
 - c. Audible alarm that sounds when unauthorized use of door occurs.
 - d. Automatic rearming after authorized use[, **with adjustable time delay**].
 - e. Remote signal capability for connection to remote indicating panel.
 - f. **<Insert feature>**.

2.15 SURFACE BOLTS

A. Surface Bolts: BHMA A156.16.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

B. Half-Round Surface Bolts: [**Grade 1**] [**Grade 2**], **6-inch (152-mm)** polished-brass or burnished-steel, half-round rod and knob; minimum **7/8-inch (22-mm)** throw; with universal strike.

- C. Interlocking Surface Bolts: [**Grade 1**] [**Grade 2**], **6-inch (152-mm)** extruded-brass or aluminum, interlocking track and rod; minimum **15/16-inch (24-mm)** throw; with universal or mortise strike.
- D. Fire-Rated Surface Bolts: [**Grade 1**] [**Grade 2**], **8-inch (203-mm)** steel bolt with 2 steel guides; minimum **1-inch (25-mm)** throw; listed and labeled for use in fire-rated assemblies; with universal strike.
- E. Dutch-Door Surface Bolts: [**Grade 1**] [**Grade 2**], polished-brass bolt and knob, minimum **3/4-inch (19-mm)** throw, with standard strike.

2.16 MANUAL FLUSH BOLTS

- A. Manual Flush Bolts: BHMA A156.16; minimum **3/4-inch (19-mm)** throw; designed for mortising into door edge.
 - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Manual-Extension Flush Bolts: [**Grade 1**] [**Grade 2**], fabricated from extruded brass or aluminum, with **12-inch (305-mm)** rod actuated by flat lever.
 - 1. Strike: [**Matching**] [**Dustproof**].
 - 2. Fire Rated: Listed and labeled for use in fire-rated assemblies.
- C. Slide Flush Bolts: [**Grade 1**] [**Grade 2**], cast brass, with rod actuated by slide.
 - 1. Strike: [**Matching**] [**Dustproof**].
- D. Tubular Bolts: [**Grade 1**] [**Grade 2**], polished-brass or polished-bronze, oval turn knob and escutcheon; minimum **9/16-inch (14-mm)** steel bolt with **1/2-inch (13-mm)** throw.
 - 1. Strike: [**Matching**] [**Dustproof**].
- E. Top-Bolt Extension Rod Length: As required to locate operating mechanism at not more than **72 inches (1829 mm)** above the finished floor at all times.
- F. Dustproof Strikes: [**Locking type**], Grade 1, polished wrought brass, with **3/4-inch- (19-mm-)** diameter, spring-tension plunger.

2.17 AUTOMATIC AND SELF-LATCHING FLUSH BOLTS

- A. Automatic Flush Bolts: BHMA A156.3, Type 25; minimum **3/4-inch (19-mm)** throw; designed for mortising into door edge. [**Include wear plates.**]
 - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Self-Latching Flush Bolts: BHMA A156.3, Type 27; minimum **3/4-inch (19-mm)** throw; designed for mortising into door edge. [**Include wear plates.**]

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

C. Dustproof Strikes: [**Locking type**,] Grade 1, polished wrought brass, with **3/4-inch- (19-mm-)** diameter, spring-tension plunger.

2.18 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items: BHMA A156.3.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

B. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing in accordance with UL 305.

C. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing in accordance with UL 305 and NFPA 252.

D. Rim Exit Devices: [**Grade 1**] [**Grade 2**].

1. Type: [**1, rim**] [**4, narrow stile**] [**28, incorporating a deadbolt**].

2. Actuating Bar: [**Cross bar**] [**Push pad**] [**Narrow-stile push pad**].

3. Material: [**Brass**] [**Bronze**] [**Stainless steel**] [**Aluminum**] [**Wrought steel**].

4. Electrified Features:

a. Push pad monitor switch.

b. Double push pad monitor switch.

c. Electric locking and unlocking.

d. Fail-secure electric latch retraction (dogging) that engages latch when fire-alarm system is activated.

e. Delayed egress.

f. Alarm.

g. **<Insert feature>**.

E. Mortise Exit Devices: [**Grade 1**] [**Grade 2**].

1. Type: [**3**] [**10, narrow stile**].

2. Actuating Bar: [**Cross bar**] [**Push pad**] [**Narrow-stile push pad**].

3. Material: [**Brass**] [**Bronze**] [**Stainless steel**] [**Aluminum**] [**Wrought steel**].

4. Electrified Features:

a. Push pad monitor switch.

b. Double push pad monitor switch.

c. Electric locking and unlocking.

d. Fail-secure electric latch retraction (dogging) that engages latch when fire-alarm system is activated.

e. Delayed egress.

f. Alarm.

- g. <Insert feature>.
- F. Surface Vertical-Rod Exit Devices: [Grade 1] [Grade 2].
- 1. Type: [2] [**5, narrow stile**].
 - 2. Actuating Bar: [**Cross bar**] [**Push pad**] [**Narrow-stile push pad**].
 - 3. Material: [**Brass**] [**Bronze**] [**Stainless steel**] [**Aluminum**] [**Wrought steel**].
 - 4. Configuration: [**Top and bottom rods**] [**Top rod**].
 - 5. Electrified Features:
 - a. Push pad monitor switch.
 - b. Double push pad monitor switch.
 - c. Electric locking and unlocking.
 - d. Fail-secure electric latch retraction (dogging) that engages latch when fire-alarm system is activated.
 - e. Delayed egress.
 - f. Alarm.
 - g. <Insert feature>.
- G. Concealed Vertical-Rod Exit Devices: [Grade 1] [Grade 2].
- 1. Type: [**6, narrow stile**] [**7, for wood doors**] [**8, for metal doors**].
 - 2. Actuating Bar: [**Cross bar**] [**Push pad**] [**Narrow-stile push pad**].
 - 3. Material: [**Brass**] [**Bronze**] [**Stainless steel**] [**Aluminum**] [**Wrought steel**].
 - 4. Configuration: [**Top and bottom rods**] [**Top rod**].
 - 5. Electrified Features:
 - a. Push pad monitor switch.
 - b. Double push pad monitor switch.
 - c. Electric locking and unlocking.
 - d. Fail-secure electric latch retraction (dogging) that engages latch when fire-alarm system is activated.
 - e. Delayed egress.
 - f. Alarm.
 - g. <Insert feature>.
- H. Combination Exit Devices: [Grade 1] [Grade 2].
- 1. Type: [**9, rim and surface vertical rod**] [**11, mortise and surface vertical rod**] [**12, mortise and concealed vertical rod**].
 - 2. Actuating Bar: [**Cross bar**] [**Push pad**] [**Narrow-stile push pad**].
 - 3. Material: [**Brass**] [**Bronze**] [**Stainless steel**] [**Aluminum**] [**Wrought steel**].
 - 4. Electrified Features:
 - a. Push pad monitor switch.
 - b. Double push pad monitor switch.
 - c. Electric locking and unlocking.
 - d. Fail-secure electric latch retraction (dogging) that engages latch when fire-alarm system is activated.
 - e. Delayed egress.

- f. Alarm.
 - g. <Insert feature>.
- I. Automatic Latching Two-Point Bolts: Grade 1.
 - 1. Type: [**23, concealed**] [**24, surface**].
 - 2. Material: [**Brass**] [**Bronze**] [**Stainless steel**].
 - J. Extension Flush Bolt Sets: BHMA A156.3; Grade 1.
 - 1. Type: [**25, automatic**] [**27, self-latching**].
 - 2. Material: [**Brass**] [**Bronze**] [**Stainless steel**].
 - K. Electronic Exit Bars: Nonlatching electronic actuating (releasing) device activated by an adjustable capacitance sensor and with no moving parts; listed and labeled as panic exit hardware. Fabricate bar from extruded aluminum, and provide door and frame transfer device and **16 ft. (4.9 m)** of cord to route wiring off the door frame.
 - L. Extruded-Aluminum Removable Mullions: With malleable-iron top and bottom retainers, and prepared for strikes as follows:
 - 1. Strikes: [**Two standard recessed strikes**] [**Two monitor strikes**] [**One standard and one electric strike with disconnect for wiring harness at top of mullion**].
 - M. Tube-Steel Removable Mullions: With malleable-iron top and bottom retainers, and prepared for strikes as follows:
 - 1. Strikes: [**Two standard recessed strikes**] [**Two monitor strikes**] [**One standard and one electric strike with disconnect for wiring harness at top of mullion**].
 - N. Fire-Exit Removable Mullions: Provide removable mullions for use with fire exit devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing in accordance with UL 305 and NFPA 252. Use mullions only with exit devices for which they have been tested.
 - O. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 - 1. Operation: [**Rigid**] [**Movable**] [**Movable with monitor switch**].
 - P. Exit Device Outside Trim: [**Lever**] [**Lever with cylinder**] [**Knob**] [**Knob with cylinder**] [**Pull**] [**Pull with cylinder**] [**Thumb turn with cylinder**]; material and finish to match locksets unless otherwise indicated.
 - 1. Match design for lock trim unless otherwise indicated.
 - Q. Through-Bolt Fasteners: For exit devices and trim on [**metal doors**] [**non-fire-rated wood doors**] [**fire-rated wood doors**].

2.19 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. **[Provide cylinder from same manufacturer of locking devices.]**
 - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Standard Lock Cylinders: BHMA A156.5; **[Grade 1] [Grade 1A] [Grade 2]** permanent cores; face finished to match lockset.
 - 1. Core Type: **[Interchangeable] [Removable]**.
 - 2. Number of Pins: **[Five] [Six] [Seven]**.
 - 3. Lock Type: **[Mortise] [Rim] [Bored-lock]** type.
- C. High-Security Lock Cylinders: BHMA A156.30; **[Grade 1] [Grade 2] [Grade 3]** permanent cores that are removable; face finished to match lockset.
 - 1. Type: **[M, mechanical] [E, electrical]**.
 - 2. Number of Pins: **[Six] [Seven]**.
 - 3. Lock Type: **[Mortise] [Rim] [Bored-lock]** type.
- D. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
- E. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.20 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock. **[Incorporate decisions made in keying conference.]**
 - 1. No Master Key System: Only change keys operate cylinders.
 - a. Provide three cylinder change keys.
 - 2. Master Key System: Change keys and a master key operate cylinders.
 - a. Provide three cylinder change keys and five master keys.
 - 3. Grand Master Key System: Change keys, a master key, and a grand master key operate cylinders.
 - a. Provide three cylinder change keys and five each of master and grand master keys.
 - 4. Great-Grand Master Key System: Change keys, a master key, a grand master key, and a great-grand master key operate cylinders.

- a. Provide three cylinder change keys and five each of master, grand master, and great-grand master keys.
5. Existing System:
 - a. Master key or grand master key locks to Owner's existing system.
 - b. Re-key Owner's existing master key system into new keying system.
6. Keyed Alike: Key all cylinders to same change key.
- B. Keys: **[Nickel silver]** **[Brass]**.
 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: **["DO NOT DUPLICATE."]** **[Information to be furnished by Owner.]**

2.21 KEY CONTROL SYSTEM

- A. Key Control Cabinet: BHMA A156.28; metal cabinet with baked-enamel finish; containing key-holding hooks, labels, two sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with key capacity of **[150]** **<Insert number>** percent of the number of locks.
 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Multiple-Drawer Cabinet: **[Grade 1]** **[Grade 2]** cabinet with drawers equipped with key-holding panels and key envelope storage, and progressive-type ball-bearing suspension slides. Include single cylinder lock to lock all drawers.
 3. Wall-Mounted Cabinet: **[Grade 1]** **[Grade 2]** cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.
 4. Portable Cabinet: **[Grade 1]** **[Grade 2]** tray for mounting in file cabinet, equipped with key-holding panels, envelopes, and cross-index system.
- B. Key Lock Boxes: Designed for storage of **[two]** **[10]** **<Insert number>** keys.
 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Features:
 - a. Tamper switches to connect to intrusion detection system.
 - b. **<Insert feature>**.
- C. Key Control System Software: Multiple-index system for recording and reporting key-holder listings, tracking keys and lock and key history, and printing receipts for transactions. Include instruction manual.
 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

2.22 OPERATING TRIM

- A. Operating Trim: BHMA A156.6; [**aluminum**] [**brass**] [**bronze**] [**stainless steel**] unless otherwise indicated.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Flat Push Plates: With square corners and beveled edges; secured with exposed screws.
1. Thickness: [**0.050 inch (1.3 mm)**] [**1/8 inch (3.2 mm)**] <Insert dimension>.
 2. Size: [**4 inches wide by 16 inches high (102 mm wide by 406 mm high)**] <Insert dimensions>.
- C. Push-Pull Plates: With square corners, beveled edges, and raised integral lip; secured with exposed screws.
1. Thickness: [**1/8 inch (3.2 mm)**] <Insert dimension>.
 2. Size: [**3-1/2 inches wide by 15-3/4 inches high (89 mm wide by 400 mm high)**] <Insert dimensions>.
- D. Straight Door Pulls:
1. Type: [**3/4-inch (19-mm) constant-diameter**] [**variable-diameter**] [**flattened-round**] [**hospital-type**] pull.
 2. Mounting: [**Surface applied with concealed fasteners**] [**Through bolted with oval-head machine screws and countersunk washers**] [**Back to back with threaded sleeves**].
 3. Minimum Clearance: [**1-1/2 inches (38 mm)**] <Insert dimension> from face of door.
 4. Overall Length: [**9 inches (229 mm)**] <Insert dimension>.
- E. Offset Door Pulls: [**1-inch (25-mm)**] <Insert dimension> constant-diameter pull.
1. Mounting: [**Surface applied with concealed fasteners**] [**Through bolted with oval-head machine screws and countersunk washers**] [**Back to back with threaded sleeves**].
 2. Offset: [**2 inches (51 mm)**] <Insert dimension>.
 3. Minimum Clearance: [**2-1/4 inches (57 mm)**] <Insert dimension> from face of door.
 4. Overall Length: [**9 inches (229 mm)**] <Insert dimension>.
- F. Flush Door Pulls: Mortised **1/2 inch (13 mm)** deep; secured with screws.
1. Shape: [**Rectangular with rectangular recess**] <Insert description>.
 2. Size: [**3-1/2 inches wide by 4-3/4 inches high (89 mm wide by 121 mm high)**] <Insert dimensions>.
- G. Straight Pull-Plate Door Pulls: Pull fixed to **0.050-inch- (1.3-mm-)** thick plate, [**4 inches wide by 16 inches high (102 mm wide by 406 mm high)**] <Insert dimensions> with square corners and beveled edges.

1. Type: [**3/4-inch (19-mm) constant-diameter**] [**variable-diameter**] [**flattened-round**] [**hospital-type**] pull.
 2. Mounting: [**Surface applied with concealed fasteners**] [**Through bolted with oval-head machine screws and countersunk washers**] [**Back to back with threaded sleeves**].
 3. Minimum Pull Clearance: [**1-1/2 inches (38 mm)**] <Insert dimension> from face of door.
 4. Overall Pull Length: [**9 inches (229 mm)**] <Insert dimension>.
- H. Offset Push-Pull Door Pulls: Pull fixed to **0.050-inch- (1.3-mm-)** thick plate, [**4 inches wide by 16 inches high (102 mm wide by 406 mm high)**] <Insert dimensions> with square corners and beveled edges.
1. Pull Diameter: [**1-inch (25-mm)**] <Insert dimension> constant diameter.
 2. Pull Offset: [**2 inches (51 mm)**] <Insert dimension>.
 3. Minimum Pull Clearance: [**2-1/4 inches (57 mm)**] <Insert dimension> from face of door.
 4. Overall Pull Length: [**9 inches (229 mm)**] <Insert dimension>.
- I. Single Push Bar: Horizontal-bar type.
1. Mounting: [**Surface applied with concealed fasteners**] [**Through bolted with oval-head machine screws and countersunk washers**].
 2. Shape and Size: [**1-inch (25-mm) constant-diameter round bar**] [**Minimum 3/8-by-1-1/4-inch (10-by-32-mm) flat bar**] <Insert shape and size>.
 3. Minimum Clearance: [**1-1/2 inches (38 mm)**] <Insert dimension> from face of door.
- J. Double Pull Bar: Two horizontal bars connected by matching vertical pull bar and spaced at [**8 inches (200 mm)**] <Insert dimension> o.c.
1. Mounting: [**Surface applied with concealed fasteners**] [**Through bolted with oval-head machine screws and countersunk washers**].
 2. Shape and Size: [**1-inch (25-mm) constant-diameter round bars**] [**Minimum 3/8-by-1-1/4-inch (10-by-32-mm) flat bars**] <Insert shape and size>.
 3. Minimum Clearance: [**1-1/2 inches (38 mm)**] <Insert dimension> from face of door.
- 2.23 ACCESSORIES FOR PAIRS OF DOORS
- A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release[; **and with internal override**].
 - B. Carry-Open Bars: BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
 - C. Flat Overlapping Astragals: BHMA A156.22; flat [**primed steel**] [**zinc-plated steel**] [**aluminum**] [**stainless steel**] [**brass**] metal bar, surface mounted on face of door with screws; minimum **1/8 inch (3.2 mm)** thick by **2 inches (51 mm)** wide by full height of door.

- D. Rigid, Housed Astragals: BHMA A156.22; gasket material held in place by metal housing; fastened to face of door with screws.
 - 1. Gasket Material: [**Closed-cell sponge silicone**] [**Closed-cell sponge neoprene**] [**Neoprene**] [**Silicone bulb**].
 - 2. Housing Material: [**Aluminum**] [**Copper alloy (brass or bronze)**].
- E. Overlapping-with-Gasket Astragals: BHMA A156.22; T-shaped metal, surface mounted on edge of door with screws.
 - 1. Base Metal: [**Primed steel**] [**Zinc-plated steel**] [**Aluminum**] [**Stainless steel**].
 - 2. Gasket Material: [**Vinyl**] [**Silicone**] [**Sponge neoprene**] [**Brush pile**] [**Polypropylene**].

2.24 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
 - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Cast-Aluminum Surface Closers: [**Grade 1**] [**Grade 2**]; Traditional type with mechanism enclosed in cast-aluminum alloy shell.
 - 1. Mounting: [**Hinge side**] [**Opposite hinge side**] [**Parallel arm**] [**Bracket**].
 - 2. Type: [**Regular arm**] [**Fusible-link holder arm**] [**Two-point hold-open arm**] [**Delayed action closing**] **<Insert type>**.
 - 3. Backcheck: [**Factory preset**] [**Adjustable**], effective between 60 and 85 degrees of door opening.
- C. Surface Closer without Cover: [**Grade 1**] [**Grade 2**]; Modern type.
 - 1. Mounting: [**Hinge side**] [**Opposite hinge side**] [**Parallel arm**] [**Bracket**] [**Hinge side top jamb**] [**Opposite side top jamb**].
 - 2. Type: [**Regular arm**] [**Hold open**] [**Fusible-link holder arm**] [**Slide track arm**] [**Dead stop**] [**Dead stop hold open**] [**Delayed action closing**] **<Insert type>**.
 - 3. Backcheck: [**Factory preset**] [**Adjustable**], effective between 60 and 85 degrees of door opening.
 - 4. Closing Power Adjustment: At least [**50**] [**35**] [**15**] percent more than minimum tested value.
- D. Surface Closer with Cover: [**Grade 1**] [**Grade 2**]; Modern type with mechanism enclosed in cover.
 - 1. Mounting: [**Hinge side**] [**Opposite hinge side**] [**Parallel arm**] [**Bracket**] [**Hinge side, top jamb**] [**Opposite side, top jamb**].

2. Type: [**Regular arm**] [**Hold open**] [**Fusible-link holder arm**] [**Slide track arm**] [**Dead stop**] [**Dead stop hold open**] [**Delayed action closing**] <Insert type>.
3. Backcheck: [**Factory preset**] [**Adjustable**], effective between 60 and 85 degrees of door opening.
4. Cover Material: [**Aluminum**] [**Plated steel**] [**Molded plastic**].
5. Closing Power Adjustment: At least [**50**] [**35**] [**15**] percent more than minimum tested value.

2.25 CONCEALED CLOSERS

- A. Concealed Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Concealed-in-Door Closer: [**Grade 1**] [**Grade 2**]; mortised into top rail of minimum **1-3/4-inch-(44-mm-)** thick doors and track mortised into head frame; with double lever arm indicated.
 1. Type: [**Surface shoe**] [**Mortised soffit plate**].
 2. Arm: [**Regular**] [**Hold open**].
 3. Closing Power Adjustment: At least [**50**] [**35**] [**15**] percent more than minimum tested value.
- C. Concealed Overhead Closer: [**Grade 1**] [**Grade 2**]; mortised into head frame; with cast-metal body and exposed cover plate.
 1. Type: [**Exposed arm with surface shoe, single acting**] [**Concealed arm and track, butt or pivot hung, single acting**] [**Concealed arm and track, center pivoted, single acting**] [**Concealed arm and track, center pivoted, double acting**].
 2. Arm: [**Regular**] [**Automatic hold open**] [**Manually selected hold open**] [**Fusible-link holder arm**].
 3. Track: [**Regular**] [**Automatic hold open**] [**Manually selected hold open**].
 4. Cover Plate Material: [**Aluminum**] [**Plated steel**].
 5. Backcheck: [**Factory preset**] [**Adjustable**].
 6. Closing Power Adjustment: At least [**50**] [**35**] percent more than minimum tested value.
- D. Concealed Floor Closer: [**Grade 1**] [**Grade 2**]; with cement case and cast-iron closer body case and top pivot.
 1. Closer Type: [**Center pivoted; include top pivot**] [**Offset pivoted; include top pivot**] [**Independently hung**].
 2. Door-Swing Type: [**Single**] [**Double**] acting.
 3. Fire Rated: Listed for use in labeled fire-rated assemblies where indicated.
 4. Function: [**Regular**] [**Automatic hold open**] [**Manually selected hold open**] [**Delayed action closing**].
 5. Backcheck: [**Factory preset**] [**Adjustable**].

6. Closing Power Adjustment: At least **[50]** **[35]** percent more than minimum tested value.
7. Case Depth: **[Regular, 4 inches (100 mm)]** **[Shallow, 2 inches (50 mm)]**.
8. Floor Plates: Provide **[flush cover plates matching door hardware finish]** **[recessed floor plates with insert of floor finish material and extended closer spindle to accommodate thickness of floor finish]** unless thresholds are indicated.
 - a. Material: **[Aluminum]** **[Plated steel]**.

2.26 CLOSER HOLDER RELEASE DEVICES

- A. Closer Holder Release Devices: BHMA A156.15; Grade 1; closer connected with separate or integral releasing and fire- or smoke-detecting devices. Door shall become self-closing on interruption of signal to release device. Automatic release is activated by **[smoke detection system]** **[loss of power]**.
 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Type: **[Single-point hold open]** **[Multiple-point hold open]** **[Free-swinging release]**.
 3. Mounting: **[Surface mounted on face of door]** **[Surface mounted on face of top jamb]** **[Surface mounted on stop]** **[Mortised into top rail of door]** **[Mortised into top jamb]** **[Recessed into floor]**.
 4. Features:
 - a. Adjustable backcheck.
 - b. Integral smoke detector.
 - c. Adjustable spring power.
 - d. Adjustable hold-open manual release force.
 - e. **<Insert feature>**.

2.27 MECHANICAL STOPS AND HOLDERS

- A. Wall- and Floor-Mounted Stops: BHMA A156.16; **[polished cast brass, bronze, or aluminum]** **<Insert metal>** base metal.
 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Rigid-Type Floor Stop: **[Grade 1]** **[Grade 2]**; with rubber bumper.
 1. Installation: **[Surface-screw]** **[Expansion-shield]** installation.
- C. Dome-Type Floor Stop: **[Grade 1]** **[Grade 2]**; with minimum **1-inch- (25-mm-)** high bumper for doors without threshold and **1-3/8-inch- (35-mm-)** high bumper for doors with threshold.
 1. Provide with extruded-aluminum riser for carpet installations.
- D. Combination Floor Stop and Holder: **[Grade 1]** **[Grade 2]**.
 1. Installation: **[Surface-screw]** **[Expansion-shield]** installation.
 2. Hold Open: **[Semiautomatic]** **[Automatic with release by pushing door]**.

- E. Manual Combination Floor Stop and Holder: [**Grade 1**] [**Grade 2**]; 3-1/2 inches (89 mm) long, with holder, keeper, and rubber bumper.
 - 1. Installation: [**Surface-screw**] [**Expansion-shield**] installation.
- F. Chain Door Stops: Grade 2; welded chain, each end attached to compression springs, both covered with protective sleeve; for surface-screw application.
- G. Wall Bumpers: [**Grade 1**] [**Grade 2**]; with rubber bumper; 2-1/2-inch (64-mm) diameter, minimum 3/4-inch (19-mm) projection from wall; with backplate for concealed fastener installation.
 - 1. Bumper Configuration: [**Convex**] [**Concave**].
- H. Roller-Type Wall Bumpers: [**Grade 1**] [**Grade 2**]; minimum 4-3/8-inch (111-mm) projection from wall; for surface-screw application.
- I. Lever-Type Door Holders: [**Grade 1**] [**Grade 2**]; minimum 4-inch- (102-mm-) long arm that swings up and remains in vertical position; with replaceable rubber tip; for surface-screw application.
- J. Plunger-Type Door Holders: [**Grade 1**] [**Grade 2**]; minimum 1-1/8-inch (29-mm) plunger throw; with replaceable rubber tip; for surface-screw application.

2.28 ELECTROMAGNETIC STOPS AND HOLDERS

- A. Electromagnetic Door Holders: BHMA A156.15, Grade 1; [**wall-mounted electromagnetic single**] [**floor-mounted electromagnet single**] [**floor-mounted electromagnet double**] unit with strike plate attached to swinging door; coordinated with fire detectors and interface with fire-alarm system for labeled fire-rated door assemblies.
 - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

2.29 OVERHEAD STOPS AND HOLDERS

- A. Overhead Stops and Holders: BHMA A156.8.
 - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Overhead Concealed Slide Holders: Type 1; [**Grade 1**] [**Grade 2**]; hold open and release by push and pull of door unless control is set in inactive position; with stop, shock absorber, and adjustable holding pressure; for doors opening 110 degrees.
 - 1. Door Swing Type: [**Single**] [**Double**] acting.
- C. Overhead Concealed Slide Stops: Type 1; [**Grade 1**] [**Grade 2**]; release by push and pull of door unless control is set in inactive position; with stop, shock absorber, and adjustable holding pressure; for doors opening 110 degrees.

1. Door Swing Type: [**Single**] [**Double**] acting.
- D. Overhead Surface-Mounted Slide Holders: Type 2; [**Grade 1**] [**Grade 2**]; hold open and release by push and pull of door unless control is set in inactive position; with stop, shock absorber, and adjustable holding pressure; for single-acting doors opening 110 degrees.
- E. Overhead Surface-Mounted, Concealed Slide Stops: Type 2; [**Grade 1**] [**Grade 2**]; release by push and pull of door unless control is set in inactive position; with stop, shock absorber, and adjustable holding pressure; for single-acting doors opening 110 degrees.
- F. Overhead Surface-Mounted, Jointed-Arm Holders: Type 3; [**Grade 1**] [**Grade 2**]; hold open and release by push and pull of door; control capable of being set in inactive position; with stop and shock absorber; for single-acting doors opening 110 degrees.
- G. Overhead Surface-Mounted, Jointed-Arm Stops: Type 3; [**Grade 1**] [**Grade 2**]; release by push and pull of door; control capable of being set in inactive position; with stop and shock absorber; for single-acting doors opening 110 degrees.
- H. Overhead Concealed, Friction Slide Holders: Type 4; [**Grade 1**] [**Grade 2**]; with frictional element held under adjustable pressure, free-acting shoulder pivots, and shock absorber; for doors opening 110 degrees.
 1. Door Swing Type: [**Single**] [**Double**] acting.
- I. Overhead Concealed, Nonfriction Slide Stops: Type 4; [**Grade 1**] [**Grade 2**]; with nonfrictional element held under adjustable pressure and shock absorber; for [**single**] [**double**]-acting doors opening 110 degrees.
- J. Overhead Concealed, Nonfriction Slide Holders: Type 4; [**Grade 1**] [**Grade 2**]; with nonfrictional element held under adjustable pressure, automatic hold-open, and shock absorber; for doors opening 110 degrees.
 1. Door Swing Type: [**Single**] [**Double**] acting.
- K. Overhead Surface-Mounted, Friction Slide Holders: Type 5; [**Grade 1**] [**Grade 2**]; with frictional element held under adjustable pressure, free-acting shoulder pivots, and shock absorber; for single-acting doors opening 110 degrees.
- L. Overhead Surface-Mounted, Nonfriction Slide Stops: Type 5; [**Grade 1**] [**Grade 2**]; with nonfrictional element held under adjustable pressure and shock absorber; for single-acting doors opening 110 degrees.
- M. Overhead Surface-Mounted, Nonfriction Slide Holders: Type 5; [**Grade 1**] [**Grade 2**]; with nonfrictional element held under adjustable pressure, automatic hold-open, and shock absorber; for single-acting doors opening 110 degrees.
- N. Overhead Surface-Mounted Rod Holders: Type 8; [**Grade 1**] [**Grade 2**]; hold open and release by push and pull of door unless roller cam is set in inactive position; with stop, shock absorber, and adjustable spring tension; for single-acting doors opening 110 degrees.

- O. Overhead Surface-Mounted Rod Stops: Type 8; **[Grade 1]** **[Grade 2]**; release by push and pull of door unless roller cam is set in inactive position; with stop, shock absorber, and adjustable spring tension; for single-acting doors opening 110 degrees.
- P. Overhead Surface-Mounted Cantilever Holders: Type 9; **[Grade 1]** **[Grade 2]**; hold open and release by push and pull of door or thumb turn; with stop and shock absorber; for single-acting doors opening 110 degrees.
- Q. Overhead Surface-Mounted Cantilever Stops: Type 9; **[Grade 1]** **[Grade 2]**; release by push and pull of door or thumb turn; with stop and shock absorber; for single-acting doors opening 110 degrees.

2.30 DOOR GASKETING

- A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
 - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Maximum Air Leakage: When tested in accordance with ASTM E283 with tested pressure differential of **0.3-inch wg (75 Pa)**, as follows:
 - 1. Smoke-Rated Gasketing: **0.3 cfm/sq. ft. (3 cu. m per minute/sq. m)** of door opening.
 - 2. Gasketing on Single Doors: **0.3 cfm/sq. ft. (3 cu. m per minute/sq. m)** of door opening.
 - 3. Gasketing on Double Doors: **0.50 cfm per ft. (0.000774 cu. m/s per m)** of door opening.
- C. Adhesive-Backed Perimeter Gasketing: **[Vinyl bulb]** **[Sponge silicone]** **[Silicone]** **[Neoprene bulb]** **[Sponge neoprene]** gasket material applied to frame rabbet with self-adhesive.
- D. Spring-Metal Perimeter Gasketing: Minimum **[0.008-inch- (0.20-mm-) thick brass or bronze]** **[0.008-inch- (0.20-mm-) thick stainless steel]** **[0.012-inch- (0.30-mm-) thick aluminum]** gasket material fastened to frame rabbet with nails or screws.
- E. Rigid, Housed, Perimeter Gasketing: **[Sponge silicone]** **[Sponge neoprene]** **[Silicone bulb]** **[Polyurethane bulb]** **[Vinyl bulb]** **[Vinyl brush]** **[Nylon brush]** **[Thermoplastic elastomer]** gasket material held in place by housing; fastened to frame stop with screws.
 - 1. Housing Material: **[Aluminum]** **[Brass or bronze]** **[Stainless steel]**.
- F. Adjustable, Housed, Perimeter Gasketing: Screw-adjustable, **[sponge silicone]** **[sponge neoprene]** **[silicone bulb]** **[polyurethane bulb]** **[vinyl bulb]** **[vinyl brush]** **[nylon brush]** **[thermoplastic elastomer]** gasket material held in place by housing; fastened to frame stop with screws.
 - 1. Housing Material: **[Aluminum]** **[Brass or bronze]** **[Stainless steel]**.
- G. Interlocking Perimeter Gasketing: Minimum **[0.018-inch- (0.46-mm-) thick zinc]** **[0.015-inch- (0.38-mm-) thick bronze]** gasket material consisting of two pieces, one fastened to door and one fastened to frame, that interlock when door is closed; mounted with screws.

- H. Overlapping Astragals for Meeting Stiles: [**EPDM strip**] [**Vinyl strip**] [**Nylon brush**] gasket material held in place by housing and overlapping when doors are closed; mounted to face of meeting stile with screws.
1. Housing Material: [**Aluminum**] [**Bronze**].
 2. Mounting: Surface mounted on face of [**each**] [**one**] door.
- I. Meeting Astragals for Meeting Stiles: [**Silicone bulb**] [**Neoprene bulb**] [**Vinyl bulb**] [**Nylon brush**] [**Brush pile**] [**Thermoplastic elastomer**] gasket material held in place by housing; mounted with screws.
1. Housing Material: [**Aluminum**] [**Bronze**].
 2. Mounting: [**Surface mounted on face of each door**] [**Surface mounted on face of one door**] [**Semimortised into edge of each door**] [**Semimortised into edge of one door**] [**Mortised into edge of each door**] [**Mortised into edge of one door**].
- J. Adjustable Astragals for Meeting Stiles: Screw-adjustable, [**silicone**] [**neoprene**] [**vinyl**] [**vinyl-covered magnet**] [**brush pile**] [**thermoplastic elastomer**] gasket material held in place by housing; mounted with screws.
1. Housing Material: [**Aluminum**] [**Bronze**].
 2. Mounting: [**Surface mounted on face**] [**Semimortised into edge**] [**Mortised into edge**] of each door.
- K. Door Sweeps: [**Neoprene**] [**Vinyl**] [**Nylon brush**] [**Polyurethane**] [**Silicone**] gasket material held in place by flat housing or flange; surface mounted to face of door with screws.
1. Housing or Flange Material: [**Aluminum**] [**Bronze**].
- L. Door Shoes: [**Vinyl**] [**Thermoplastic elastomer**] [**Neoprene**] [**Brush pile**] gasket material held in place by housing; mounted to bottom edge of door with screws.
1. Housing Material: [**Aluminum**] [**Bronze**].
 2. Extended Housing: [**One side**] [**Both sides**] of door.
 3. Mounting: [**Surface mounted on**] [**Mortised into**] bottom edge of door.
- M. Automatic Door Bottoms: [**Sponge neoprene**] [**Sponge silicone**] [**Thermoplastic elastomer**] [**Nylon brush**] gasket material held in place by housing that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.
1. Housing Material: [**Aluminum**] [**Bronze**] [**Aluminum lined with 0.047-inch (1.2-mm) thick lead**].
 2. Mounting: [**Semimortised into bottom**] [**Mortised into bottom**] of door.
 3. Type: Low-closing-force type for doors required to meet accessibility requirements.

2.31 THRESHOLDS

- A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Compressing-Top Thresholds: Metal member with compressible vinyl seal on top of threshold that seals against bottom of door; and base metal of **[aluminum]** **[extruded bronze]** **[stainless steel]**.
- C. Saddle Thresholds:
 1. Type: **[Smooth top]** **[Fluted top]** **[Fluted top and offset]** **[Thermal break and fluted top]** **[Applied gasketed stop and fluted top]** **[Carpet separator with fluted top]** **[Fluted top, barrier free]**.
 2. Base Metal: **[Aluminum]** **[Extruded bronze]** **[Stainless steel]**.
- D. Half-Saddle Thresholds: Fluted-top metal member; and base metal of **[aluminum]** **[extruded bronze]**.
- E. Interlocking Thresholds: Fluted-top metal member with integral lip designed to engage a hook strip applied to door.
 1. Type: **[Single lip]** **[Double lip]** **[Double-lip water return]** **[Double-lip water return with aluminum pan]** **[Single lip with thermal barrier]**.
 2. Base Metal: **[Aluminum]** **[Extruded bronze]**.
- F. Latching/Rabbeted Thresholds:
 1. Type: **[Fluted]** **[Smooth]** **[Offset with fluted]** top.
 2. Base Metal: **[Aluminum]** **[Extruded bronze]**.
- G. Latching/Rabbeted Thresholds with Gasket: Fluted-top metal member with gasket.
 1. Type: **[Offset]** **[Thermal barrier]**.
 2. Base Metal: **[Aluminum]** **[Extruded bronze]**.
 3. Gasket Material: **[Vinyl]** **[Silicone]** **[Neoprene]** **[Brush pile]** **[Closed-cell sponge neoprene]**.
- H. Latching/Rabbeted Panic Thresholds:
 1. Type: **[Fluted, barrier free]** **[Fluted with gasket]** top.
 2. Base Metal: **[Aluminum]** **[Extruded bronze]**.
- I. Plate Thresholds: Solid metal plate.
 1. Top Surface: Fluted[**with slip-resistant abrasive**].
 2. Base Metal: **[Aluminum]** **[Extruded brass or bronze]** **[Stainless steel]**.
- J. Ramped Thresholds: Modular, interlocking, sloped, fluted-top metal assemblies with closed return ends; 1:12 slope.
 1. Top Surface: Fluted[**with slip-resistant abrasive**].
 2. Base Metal: **[Aluminum]** **[Extruded bronze]**.

- K. Saddle Thresholds for Floor Closers: Fluted top.
1. Type: [A, for center-hung doors; ends not mitered] [B, for offset-hung doors; ends not mitered] [C, for center-hung doors; ends mitered] [D, for offset-hung doors; ends mitered].
 2. Base Metal: [Aluminum] [Extruded bronze].

2.32 SLIDING DOOR HARDWARE

- A. Sliding Door Hardware: BHMA A156.14; consisting of complete sets including rails, hangers, supports, bumpers, floor guides, and accessories indicated.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Horizontal Sliding Door Hardware: Grade 1; rated for minimum door weight of [240 lb (109 kg)] [320 lb (145 kg)] [450 lb (205 kg)] [560 lb (254 kg)] [640 lb (290 kg)] [800 lb (363 kg)] [1000 lb (455 kg)] [1500 lb (681 kg)] <Insert weight>.
1. Material: [Wrought steel] [Galvanized steel or anodized aluminum].
 2. Rail: [Box without mounting brackets] [Box with attached mounting brackets] [Box with attached flashing] [Round without mounting brackets] [Round with attached mounting brackets].
 3. Rail Supports: [Single sidewall] [Double sidewall] [Triple sidewall] [Single overhead] [Single overhead parallel] [Single overhead cross-ear] [Double overhead cross-ear] [Triple overhead cross-ear] style.
 - a. Provide intermediate-, end-, and splice-type track supports as required by rail configuration and door weight indicated.
 4. Hanger Configuration: Four-wheel [truck] [hanger assembly with top mounting plate] [hanger assembly with drop bolt] [hanger assembly with single drop strap] [hanger assembly with double drop strap] <Insert hanger configuration>.
 - a. Wheel Assembly: Steel wheels with ball bearings.
 5. Accessories:
 - a. Continuous bottom guide.
 - b. Guide rail and guide rail brackets as required by rail configuration.
 - c. Bow handle, minimum 6 inches (150 mm) in overall length.
 - d. Flush pull, minimum 4 by 5-1/2 by 3/4 inch (100 by 140 by 19 mm), mortised into door.
 - e. Cane bolt, minimum 1/2-inch (13-mm) diameter by 12 inches (305 mm) long.
 - f. Stay roller, minimum 2-inch- (50-mm-) diameter wheel.
 - g. Floor center stop of cast iron.
 - h. End guide and stop.
 - i. Parallel door floor guides.
 - j. Door stop.
 - k. Sliding door latch.

- l. Bumper shoe, minimum **0.0598-inch (1.5-mm)** thickness.
 - m. Cremona bolt with lever handle, minimum **1/2-inch- (13-mm-)** diameter oval or round rod, and rod guides at **24 inches (610 mm)** o.c.
 - n. Top spring bolt, minimum [**6 inches (150 mm)**] [**8 inches (200 mm)**]; malleable iron and with angle or surface strike and **24-inch (610-mm)** chain.
 - o. Foot bolt minimum [**6 inches (150 mm)**] [**8 inches (200 mm)**]; wrought steel, cast iron, or malleable iron.
- C. Bypassing Sliding Door Hardware: Rails and door hardware that allow vertical adjustment and rated for doors weighing up to [**120 lb (54 kg) Grade 1**] [**80 lb (36 kg) Grade 1**] [**40 lb (18 kg) Grade 2**].
1. Rail Material: [**Galvanized wrought steel**] [**Extruded aluminum**].
 2. Rail Configuration: [**V-grooved double leg**] [**V-grooved double leg with fascia**] [**I-beam**].
 3. Mounting: [**Top hung**] [**Bottom supporting with overhead guide**].
 4. Wheel Assembly: Two wheel or four wheel, with roller bearings.
 5. Pulls: [**Flush, mortised into door**] [**Cast, forged, or extruded brass or bronze surface-applied type**] [**Wrought brass or bronze edge type, mortised into edge of door**] [**Sliding door latch**] [**Sliding door lock with emergency release**].
 6. Accessories:
 - a. Bumper stops; wrought steel.
 - b. Floor guides.
- D. Pocket Sliding Door Hardware: Grade 1; rated for doors weighing up to [**120 lb (54 kg)**] [**80 lb (36 kg)**], overhead box rails and door hardware that allows vertical adjustment.
1. Rail Material: [**Galvanized wrought steel**] [**Extruded aluminum**].
 2. Door Type: [**Single**] [**Biparting**].
 3. Rail Configuration: [**V-grooved double leg**] [**I-beam**].
 4. Wheel Assembly: Two wheel or four wheel, with roller bearings.
 5. Pulls: [**Flush, mortised into door**] [**Cast, forged, or extruded brass or bronze surface-applied type**] [**Wrought brass or bronze edge type, mortised into edge of door**] [**Sliding door latch**] [**Sliding door lock with emergency release**].
 6. Accessories:
 - a. Bumper stops; wrought steel.
 - b. Floor guides installed within pocket.
- 2.33 FOLDING DOOR HARDWARE
- A. General: BHMA A156.14; complete sets including overhead rails, hangers, supports, bumpers, floor guides, and accessories indicated.
 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 - B. Bifolding Door Hardware: Rated for door panels weighing up to [**50 lb (23 kg) Grade 1**] [**30 lb (14 kg) Grade 2**]; with rails and door hardware that allow horizontal and vertical adjustment.

1. Rail Material: [**Galvanized wrought steel**] [**Extruded aluminum**].
 2. Rail Configuration: [**V-grooved double leg**] [**V-grooved double leg with fascia**] [**I-beam**].
 3. Mounting: [**Surface mounted overhead**] [**Top and bottom hung**].
 4. Wheel Assembly: Two wheel or four wheel, with roller bearings.
- C. Multiple Folding Door Hardware: Rated for door panels weighing up to [**50 lb (23 kg) Grade 1**] [**30 lb (14 kg) Grade 2**]; with rails and door hardware that allows horizontal and vertical adjustment.
1. Rail Material: [**Galvanized wrought steel**] [**Extruded aluminum**].
 2. Rail Configuration: [**V-grooved double leg**] [**V-grooved double leg with fascia**] [**I-beam**].
 3. Mounting: [**Surface mounted overhead**] [**Top and bottom hung**].
 4. Wheel Assembly: Two wheel or four wheel, with roller bearing.

2.34 METAL PROTECTIVE TRIM UNITS

- A. Metal Protective Trim Units: BHMA A156.6; fabricated from **0.050-inch- (1.3-mm-)** thick [**aluminum**] [**brass**] [**bronze**] [**stainless steel**]; with manufacturer's standard machine or self-tapping screw fasteners.
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Armor Plates: [**36 inches (914 mm)**] [**40 inches (1016 mm)**] [**42 inches (1067 mm)**] high by door width with allowance for frame stops.
- C. Kick Plates: [**8 inches (203 mm)**] [**10 inches (254 mm)**] [**12 inches (305 mm)**] **<Insert dimension>** high by door width with allowance for frame stops.
- D. Mop Plates: [**4 inches (102 mm)**] [**6 inches (152 mm)**] high by **1 inch (25 mm)** less than door width.
- E. Stretcher Plates: [**6 inches (152 mm)**] [**8 inches (203 mm)**] high by door width with allowance for frame stops.
- F. Nonmortise Angle Door Edging: [**48-inch- (1220-mm-)**] [**42-inch- (1067-mm-)**] high by minimum **0.050-inch- (1.3-mm-)** thick metal sheet formed into angle shape; with **1-1/4-inch (32-mm)** length of leg on face of door; for surface mounting on door.
1. Leg Offset: To accommodate door protection plate of type indicated.
- G. Mortise Angle Door Edging: [**48-inch- (1220-mm)**] [**42-inch- (1067-mm-)**] high by minimum **0.050-inch- (1.3-mm-)** thick metal sheet formed into angle shape; with **7/8-inch (22-mm)** length of leg on face of door; for mortise application into edge of door.
- H. Nonmortise Cap Door Edging: [**48-inch- (1220-mm)**] [**42-inch- (1067-mm-)**] high by minimum **0.050-inch- (1.3-mm-)** thick metal sheet formed into "U" shape; with **1-1/4-inch (32-mm)** length of leg on faces of door; for surface mounting on door.

1. Leg Offset: To accommodate door protection plate of type indicated.

- I. Mortise Cap Door Edging: [~~48-inch- (1220-mm)~~] [~~42-inch- (1067-mm-)~~] high by minimum ~~0.050-inch- (1.3-mm-)~~ thick metal sheet formed into "U" shape; with ~~7/8-inch (22-mm)~~ length of leg on faces of door; for mortise application into edge of door.

2.35 PLASTIC PROTECTION PLATES

- A. Plastic Protection Plates: BHMA A156.6; fabricated with four sides beveled; [**plastic laminate; 1/8 inch (3.2 mm) thick; NEMA LD 3, Grade HGS**] [**rigid plastic; 0.060-inch- (1.5-mm-) thick, PVC or acrylic-modified vinyl plastic**] [**acrylic; 1/8 inch (3.2 mm) thick**].

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

- B. Armor Plates: [**36 inches (914 mm)**] [**40 inches (1016 mm)**] [**42 inches (1067 mm)**] high by door width with allowance for frame stops.

- C. Kick Plates: [**8 inches (203 mm)**] [**10 inches (254 mm)**] [**12 inches (305 mm)**] **<Insert dimension>** high by door width with allowance for frame stops.

- D. Mop Plates: [**4 inches (102 mm)**] [**6 inches (152 mm)**] high by **1 inch (25 mm)** less than door width.

- E. Stretcher Plates: [**6 inches (152 mm)**] [**8 inches (203 mm)**] high by door width with allowance for frame stops.

- F. Colors and Textures: [**As selected by Architect from manufacturer's full range**] [**Match Architect's sample**] [**As indicated by manufacturer's designations in door hardware schedule**].

2.36 AUXILIARY DOOR HARDWARE

- A. Auxiliary Hardware: BHMA A156.16.

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

- B. Chain Door Guards: [**Grade 1**] [**Grade 2**] [**Grade 3**]; polished cast brass or bronze or extruded brass; with plate slotted to receive ~~6-inch- (150-mm-)~~ long welded chain secured to an anchor plate. Guard allows door to be opened ~~3 inches (75 mm)~~ with chain engaged in slotted plate. Equip with chain holder.

- C. Rod-Type Door Guards: [**Grade 1**] [**Grade 2**] [**Grade 3**]; straight door-mounted rod that engages U-shaped, jamb-mounted rod. U-shaped rod can swing 180 degrees away from door; rod limits door opening when engaged.

1. Material: [**Brass**] [**Bronze**] [**Aluminum**].

- D. Coat Hooks: [Grade 1] [Grade 2] [Grade 3]; two curved hooks with rounded ends; 3-inch (75-mm) projection from wall; for surface-screw application.
 - 1. Material: [Polished cast brass] [Polished cast bronze] [Burnished cast aluminum].
- E. Garment Hooks: [Grade 1] [Grade 2] [Grade 3]; one long hat hook and one small coat hook; 3-3/4-inch (95-mm) projection from wall with 7-inch (178-mm) overall height; for surface-screw application.
 - 1. Material: [Polished cast brass] [Burnished cast aluminum].
- F. Door Knockers: Grade 1; solid brass [with engraved number and nameplates].
- G. Wide-Angle Door Viewers: [Grade 1] [Grade 2] [Grade 3]; solid brass with optical glass lenses; adjustable to door thickness and permitting one-way observation with minimum 190-degree viewing angle.
- H. Fire-Rated Door Viewers: Solid brass with optical glass lenses; listed and labeled for use in fire-rated assemblies; adjustable to door thickness, and permitting one-way observation with minimum [120] [150] [190]-degree viewing angle.
- I. House Numbers: Grade 1; [wrought, cast, or forged brass] <Insert material>; 4 inches (102mm) high; for screw application.
- J. Silencers for Wood Door Frames: Grade 1; neoprene or rubber; minimum 5/8 by 3/4 inch (16 by 19 mm); fabricated for drilled-in application to frame.
- K. Silencers for Metal Door Frames: Grade 1; neoprene or rubber; minimum diameter 1/2 inch (13 mm); fabricated for drilled-in application to frame.

2.37 AUXILIARY ELECTRIFIED DOOR HARDWARE

- A. Auxiliary Electrified Door Hardware:
 - 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Boxed Power Supplies: Modular unit in NEMA ICS 6, Type 4 enclosure; filtered and regulated; voltage rating and type matching requirements of door hardware served; listed and labeled for use with fire-alarm systems.
- C. Monitor Strikes: [Cast strike with toggle] [Dustbox monitor for installation under standard strike].
- D. Door Position Switches: Magnetically operated reed switch designed for concealed mounting.
- E. Door and Frame Transfer Devices: Steel housing for mortise in hinge stile of door, with flexible tube for wiring bundle; accommodating doors that swing open to 120 degrees.

2.38 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Architect.
 - 1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.
- C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.
 - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 - 2. Fire-Rated Applications:
 - a. Wood or Machine Screws: For the following:
 - 1) Hinges mortised to doors or frames[; **use threaded-to-the-head wood screws for wood doors and frames**].
 - 2) Strike plates to frames.
 - 3) Closers to doors and frames.
 - b. Steel Through Bolts: For the following unless door blocking is provided:
 - 1) Surface hinges to doors.
 - 2) Closers to doors and frames.
 - 3) Surface-mounted exit devices.
 - 3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
 - 4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.39 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames in accordance with ANSI/SDI A250.6.
- B. Wood Doors: Comply with door and hardware manufacturers' written instructions.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights [**indicated on Drawings**] [**to comply with the following**] unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 - 2. Custom Steel Doors and Frames: HMMA 831.
 - 3. Wood Doors: DHI's "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every **30 inches (750 mm)** of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- D. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule, but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every **30 inches (750 mm)** of door height greater than **90 inches (2286 mm)**.
- E. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 1. Replace construction cores with permanent cores as **[indicated in keying schedule]** **[directed by Owner]**.
 2. Furnish permanent cores to Owner for installation.
- F. Key Control System:
 1. Key Control Cabinet: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
 2. Key Lock Boxes: Install where indicated or approved by Architect to provide controlled access for fire and medical emergency personnel.
 3. Key Control System Software: Set up multiple-index system based on final keying schedule.
- G. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, **[above accessible ceilings]** **[in equipment room]**. Verify location with Architect.
 1. Configuration: Provide **[one power supply for each door opening]** **[least number of power supplies required to adequately serve doors]** with electrified door hardware.
- H. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."
- I. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
- J. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 1. Do not notch perimeter gasketing to install other surface-applied hardware.
- K. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- L. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: [**Owner will engage**] [**Engage**] a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
 - 1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
 - 2. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 70 degrees and so that closing time complies with accessibility requirements of authorities having jurisdiction.
 - 3. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
- B. Occupancy Adjustment: Approximately [**three**] [**six**] <Insert number> months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [**six**] [**nine**] [**12**] <Insert number> months' full maintenance by skilled employees of door

hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.8 DEMONSTRATION

- A. **[Engage Installer to train] [Train]** Owner's maintenance personnel to adjust, operate, and maintain door hardware.

3.9 DOOR HARDWARE SCHEDULE

- A. Hardware Set 1: Each door to have the following:
 - 1. **<Insert hardware type>**.

END OF SECTION 087111

SECTION 087113 - POWER DOOR OPERATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Low-energy door operators for swinging doors.

1.2 DEFINITIONS

- A. AAADM: American Association of Automatic Door Manufacturers.
- B. Activation Device: A control that, when actuated, sends an electrical signal to the door operator to open the door.
- C. Safety Device: A control that, to avoid injury, prevents a door from opening or closing.
- D. For automatic door terminology, see BHMA A156.19 for definitions of terms.

1.3 COORDINATION

- A. Templates: Distribute for doors, frames, and other work specified to be factory prepared and reinforced for installing power door operators.
- B. Coordinate hardware for doors with operators to ensure proper size, thickness, hand, function, and finish.
- C. Electrical System Roughing-in: Coordinate layout and installation of power door operators with connections to the following:
 - 1. Power supplies.
 - 2. Access-control system.
 - 3. Remote activation devices.
 - 4. Remote monitoring systems.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for power door operators.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

- B. Shop Drawings: For power door operators.
 - 1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
 - 2. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Indicate locations of activation and safety devices.
 - 4. Include diagrams for power, signal, and control wiring.
 - 5. Include plans, elevations, sections, and attachment details for guide rails.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For power door operators, safety devices, and control systems, to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for installation and maintenance of units required for this Project.
 - 1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of power door operators that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty or sporadic operation of power door operator, including controls.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering or use.
 - 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ASSA ABLOY Entrance Systems; ASSA ABLOY.
 2. Horton Automatics; Overhead Door Corporation.
 3. LCN; Allegion plc.
 4. STANLEY Access Technologies LLC; STANLEY Security Solutions, Inc.
 5. dormakaba USA Inc.
- B. Source Limitations: Obtain power door operators, including activation and safety devices, from single source from single manufacturer.

2.2 POWER DOOR OPERATORS, GENERAL

- A. General: Provide operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated; and in accordance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation and safety devices.
1. Wind Load: Provide door operators on exterior doors that will open and close doors and maintain them in fully closed position when subjected to wind load of 15 PSF.
- B. Electromechanical Operating System: Self-contained unit powered by permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor, connections for power and activation- and safety-device wiring, and manual operation, including spring closing when power is off.
- C. Hinges: See Section 087100 "Door Hardware" for hinge type for each door that door operator shall accommodate.
- D. Cover for Surface-Mounted Operators: Fabricated from ~~0.125-inch-~~ (3.2-mm-) thick, extruded or formed aluminum; continuous over full width of door opening, including door jambs; with enclosed end caps, provision for maintenance access, and fasteners concealed when door is in closed position.
- E. Brackets and Reinforcements: Fabricated from aluminum with nonstaining, nonferrous shims for aligning system components.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 LOW-ENERGY DOOR OPERATORS FOR SWINGING DOORS

- A. Standard: BHMA A156.19.

- B. Performance Requirements:
 - 1. Opening Force if Power Fails: Not more than **15 lbf (67 N)** required to release latch if provided, not more than **30 lbf (133 N)** required to manually set door in motion, and not more than **15 lbf (67 N)** required to fully open door.
 - 2. Entrapment-Prevention Force: Not more than **15 lbf (67 N)** required to prevent stopped door from closing or opening.
- C. Configuration, Single: Operator to control single swinging door.
 - 1. Traffic Pattern: Two way.
 - 2. Operator Mounting: Surface.
- D. Operation: Power opening and power-assisted spring closing. Provide time delay for door to remain open before initiating closing cycle as required by BHMA A156.19. When not in automatic mode, door operator shall function as manual door closer, with or without electrical power.
- E. Operating System: Electromechanical.
- F. Microprocessor Control Unit: Solid-state controller.
- G. Features:
 - 1. Adjustable opening and closing speed.
 - 2. Adjustable opening and closing force.
 - 3. Adjustable backcheck.
 - 4. Adjustable hold-open time from zero to 30 seconds.
 - 5. Adjustable time delay.
 - 6. Adjustable acceleration.
 - 7. Obstruction recycle.
 - 8. On-off/hold-open switch to control electric power to operator; key operated.
- H. Activation Device: Push-plate switch on each side of door to activate door operator.
- I. Exposed Finish: Finish matching door and frame.

2.4 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 1. Extrusions: **ASTM B221 (ASTM B221M)**.
 - 2. Sheet: **ASTM B209 (ASTM B209M)**.
- B. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**] <Insert alloy type>, stretcher-leveled standard of flatness, in manufacturer's standard thickness.

- C. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

2.5 CONTROLS

- A. General: Provide controls, including activation and safety devices, in accordance with BHMA standards; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated. Coordinate activation and safety devices with door operation and door operator mechanisms.
- B. Push-Plate Switch: Momentary-contact door control switch with flat push-plate actuator with contrasting-colored, engraved message.
 - 1. Configuration:
 - a. Square push plate with 4-by-4-inch (100-by-100-mm) junction box.
 - 1) Mounting: Recess mounted, semiflush in wall.
 - 2. Push-Plate Material: Stainless steel as selected by Architect from manufacturer's full range.
 - 3. Message: International symbol of accessibility and "Push to Open."
- C. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

2.6 ACCESSORIES

- A. Signage: As required by cited BHMA standard for type of door and its operation.
 - 1. Application Process: Operator manufacturer's standard process.
 - 2. Provide sign materials with instructions for field application when operators are installed.

2.7 FABRICATION

- A. Factory fabricate power door operators to comply with indicated standards.
- B. Form aluminum shapes before finishing.
- C. Fabricate exterior components to drain condensation and water-passing joints within operator enclosure to the exterior.
- D. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match operator.
- E. Provide metal cladding, completely covering visible surfaces before shipment to Project site. Fabricate cladding with concealed fasteners and connection devices, with accurately fitted joints

with ends coped or mitered to produce hairline joints free of burrs and distortion, and with allowance for thermal expansion at exterior doors.

2.8 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary, protective covering before shipping.
- B. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, door and frame preparation and reinforcements, and other conditions affecting performance of power door operators.
- B. Examine roughing-in for electrical systems to verify actual locations of power connections before power door operator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install power door operators in accordance with manufacturer's written instructions and cited BHMA standard for type of door operation and direction of pedestrian travel, including signage, controls, wiring, remote power units if any, and connection to building's power supply.
 - 1. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion.
 - 2. Install operators true in alignment with established lines and door geometry without warp or rack. Anchor securely in place.
- B. Controls: Install activation and safety devices in accordance with manufacturer's written instructions and cited BHMA standard for operator type and direction of pedestrian travel. Connect control wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Access-Control System: Connect operators to access-control system as specified in Section 281500 "Access Control Hardware Devices."

- D. Signage: Apply on both sides of each door as required by cited BHMA standard for type of door operator and direction of pedestrian travel.

3.3 ADJUSTING

- A. Adjust power door operators to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.
 - 1. Adjust operators on exterior doors for tight closure.
- B. After completing installation of power door operators, inspect exposed finishes on doors and operators. Repair damaged finish to match original finish.
- C. Readjust power door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).
- D. Occupancy Adjustment: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.4 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of power door operator Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 1. Engage a Certified Inspector to perform safety inspection after each adjustment or repair and at end of maintenance period. Furnish completed inspection reports to Owner.
 - 2. Perform maintenance, including emergency callback service, during normal working hours.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain power door operators.

END OF SECTION 087113

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Glass products.
 - 2. Laminated glass.
 - 3. Insulating glass.
 - 4. Glazing sealants.
 - 5. Glazing tapes.
 - 6. Miscellaneous glazing materials.

- B. Related Requirements:
 - 1. Section 088300 "Mirrors."
 - 2. Section 088813 "Fire-Rated Glazing."
 - 3. Section 088853 "Security Glazing."

1.2 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

- B. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036.

- C. IBC: International Building Code.

- D. Interspace: Space between lites of an insulating-glass unit.

1.3 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Sustainable Design Submittals:

1. **Product Data:** For sealants, indicating VOC content.
 2. **Laboratory Test Reports:** For sealants, indicating compliance with requirements for low-emitting materials.
- C. **Glass Samples:** For each type of glass product other than clear monolithic vision glass; **12 inches (300 mm)** square.
- D. **Glazing Schedule:** List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
- E. **Delegated Design Submittal:** For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. **Qualification Data:** For Installer.
- B. **Product Certificates:** For glass.
- C. **Product Test Reports:** For fabricated glass, for tests performed by a qualified testing agency.
- D. **Sample Warranties:** For special warranties.

1.6 QUALITY ASSURANCE

- A. **Fabricated-Glass Manufacturer Qualifications:** A qualified manufacturer of fabricated glass units who is approved by primary glass manufacturer.
- B. **Installer Qualifications:** A qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. **Protect glazing materials** in accordance with manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. **Comply with insulating-glass manufacturer's written instructions** for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.8 FIELD CONDITIONS

- A. **Environmental Limitations:** Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F (4.4 deg C).

1.9 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion.

- B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: 10 years from date of Substantial Completion.

- C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

- D. Manufacturer's Special Warranty for Heat-Soaked Tempered Glass: Manufacturer agrees to replace heat-soaked tempered glass units that spontaneously break due to nickel sulfide (NiS) inclusions at a rate exceeding 0.3 percent (3/1000) within specified warranty period. Coverage for any other cause is excluded.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Glass: Obtain coated glass from single source from single manufacturer.
- B. Source Limitations for Glazing Accessories: For each product and installation method, obtain from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.
- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:
 - 1. Design Wind Pressures: As indicated on Drawings.
 - a. Wind Design Data: As indicated on Drawings.
 - 2. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
 - 3. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.
- D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
 - 1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
 - 2. For laminated-glass lites, properties are based on products of construction indicated.
 - 3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 - 4. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
 - 5. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
 - 6. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.
- F. Acoustic Performance:
 - 1. Exterior Glazing: 27 OITC.

2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. NGA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
 - 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than thickness indicated.
 - 1. Minimum Glass Thickness for Exterior Lites: 6 mm.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
- B. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- C. Reflective- and Low-E-Coated Vision Glass: ASTM C1376.

2.5 LAMINATED GLASS

- A. Laminated Glass: ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Construction: Laminate glass with polyvinyl butyral interlayer ionoplast interlayer or cast-in-place and cured-transparent-resin interlayer to comply with interlayer manufacturer's written instructions.
2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
3. Interlayer Color: Clear unless otherwise indicated.

2.6 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.
1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
 2. Perimeter Spacer: Manufacturer's standard spacer material and construction.
 3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.7 GLAZING SEALANTS

- A. General:
1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range of industry colors.
- B. Neutral-Curing Silicone Glazing Sealant, Class 100/50: Complying with ASTM C920, Type S, Grade NS, Use NT.

2.8 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
1. AAMA 804.3 tape, where indicated.

2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.9 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks:
1. Silicone with Shore A durometer hardness of 85, plus or minus 5.
 2. Type recommended in writing by sealant or glass manufacturer.
- D. Spacers:
1. Neoprene blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
 2. Type recommended in writing by sealant or glass manufacturer.
- E. Edge Blocks:
1. Silicone with Shore A durometer hardness per manufacturer's written instructions.
 2. Type recommended in writing by sealant or glass manufacturer.
- F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.10 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 2. Presence and functioning of weep systems.
 3. Minimum required face and edge clearances.
 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
 - E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
 - F. Provide spacers for glass lites where length plus width is larger than **50 inches (1270 mm)**.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide **1/8-inch- (3-mm-)** minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
 - G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.
 - H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
 - I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
 - J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
 - K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended in writing by gasket manufacturer.
- 3.4 GASKET GLAZING (DRY)
- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
 - B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
 - C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.
 - D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-

glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

- E. Install gaskets so they protrude past face of glazing stops.

3.5 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.6 CLEANING AND PROTECTION

- A. Immediately after installation, remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer

3.7 MONOLITHIC GLASS SCHEDULE

- A. Glass Type GL-3: Clear fully tempered float glass, used where indicated for interior glazing.
 - 1. Minimum Thickness: 6 mm.
 - 2. Safety glazing required.

3.8 LAMINATED GLASS SCHEDULE

- A. Glass Type GL-4: Clear laminated glass with two plies of annealed float glass, used for interior door and vestibule glazing and as indicated.
1. Minimum Thickness of Each Glass Ply: 4 mm.
 2. Interlayer Thickness: 0.060 inch (1.52 mm).
 3. Safety glazing required.

3.9 INSULATING GLASS SCHEDULE

- A. Glass Types GL-1 and GL-1: Low-E-coated, clear insulating glass, used for window glazing and as indicated.
1. Basis-of-Design Product: Guardian SuperNeutral 54 Clear.
 2. Overall Unit Thickness: 1 inch (25 mm).
 3. Minimum Thickness of Each Glass Lite: 6 mm.
 4. Outdoor Lite: Annealed (GL-2), Fully tempered float glass (GL-1)
 5. Interspace Content: Air.
 6. Indoor Lite: Annealed (GL-2), Fully tempered float glass (GL-1)
 7. Low-E Coating: Pyrolytic or sputtered on second or third surface.
 8. Winter Nighttime U-Factor: 0.29 maximum.
 9. Summer Daytime U-Factor: 0.27 maximum.
 10. Visible Light Transmittance: 54 percent minimum.
 11. Solar Heat Gain Coefficient: 0.28 maximum.
 12. Safety glazing required.

3.10 INSULATING-LAMINATED-GLASS SCHEDULE

- A. Glass Type GL-6: Low-E-coated, clear insulating laminated glass, used for exterior door glazing and as indicated.
1. Basis-of-Design Product: Guardian SuperNeutral 54 Clear.
 2. Overall Unit Thickness: 1 inch (25 mm).
 3. Minimum Thickness of Outdoor Lite: 6 mm.
 4. Outdoor Lite: Fully tempered float glass.
 5. Interspace Content: Air.
 6. Indoor Lite: Clear laminated glass with two plies of annealed float glass.
 - a. Minimum Thickness of Each Glass Ply: 4 mm.
 - b. Interlayer Thickness: 0.060 inch (1.52 mm).
 7. Low-E Coating: Pyrolytic or sputtered on second or third surface.
 8. Winter Nighttime U-Factor: 0.29 maximum.
 9. Summer Daytime U-Factor: 0.27 maximum.
 10. Visible Light Transmittance: 54 percent minimum.
 11. Solar Heat Gain Coefficient: 0.28 maximum.
 12. Safety glazing required.

Maryland State Police
Tactical Administration Center
PA-745-210-001

END OF SECTION 088000

SECTION 088813 - FIRE-RATED GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fire-protection-rated glazing.

1.2 DEFINITIONS

- A. Fire-Protection-Rated Glazing: Glazing that prevents spread of fire and smoke and complies with requirements for rated openings; incapable of blocking radiant heat
- B. Fire-Resistance-Rated Glazing: Glazing that prevents spread of fire and smoke and radiant heat and complies with requirements for rated walls and rated openings; capable of blocking radiant heat
- C. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- D. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036.

1.3 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. **Product Data:** For sealants, indicating VOC content.
 - 2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
- C. Glass Samples: For each type of glass product; **12 inches (300 mm)** square.
- D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of glass and glazing product.
- B. Sample Warranties: For special warranties.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials in accordance with manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install fire-resistant glazing until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature conditions at occupancy levels during remainder of construction period.

1.8 WARRANTY

- A. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

- 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Glass: For each glass type, obtain from single source from single manufacturer.
- B. Glazing Accessories: For each product and installation method, obtain from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and impact loads (where applicable) without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; deterioration of glazing materials; or other defects in construction.

2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organization below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. NGA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, glass thickness, and safety glazing standard with which glass complies.

2.4 GLASS PRODUCTS

- A. Float Glass: ASTM C1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- B. Low-Iron Float Glass: ASTM C1036, Type I, Quality-Q3, Class I (clear), with visible light transmission not less than 91 percent.
- C. Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class I (clear) unless otherwise indicated, Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- D. Laminated Glass: ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
 - 1. Construction: Laminate glass with polyvinyl butyral interlayer unless fire-protection or fire-resistance rating is based on another product.
 - 2. Interlayer Thickness: Provide thickness as needed to comply with requirements.
 - 3. Interlayer Color: Clear unless otherwise indicated.

2.5 FIRE-PROTECTION-RATED GLAZING

- A. General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on positive-pressure testing in accordance with NFPA 257 or UL 9, including hose-stream test, and shall comply with NFPA 80.
 - 1. Fire-protection-rated glazing required to have a fire-protection rating of 20 minutes shall be exempt from hose-stream test.
- B. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name; test standard; whether glazing is permitted to be used in doors or openings; if permitted in openings, whether glazing has passed hose-stream test; whether

glazing meets **450 deg F (250 deg C)** temperature-rise limitation; and fire-resistance rating in minutes.

- C. Fire-Protection-Rated Monolithic Glass for Doors and Protected Openings: 19-mm thickness; low-iron fire-protection-rated glass; complying with 16 CFR 1201, Category II. UL listed and tested in accordance with NFPA 252 for fire-rated doors and NFPA 257 for protected openings with hose-stream testing.
- D. Fire-Protection-Rated Monolithic Glass for Doors Only: 19-mm thickness; clear, fire-protection glass; complying with 16 CFR 1201, Category II. UL listed and tested in accordance with NFPA 252 for fire-rated doors with hose-stream testing.

2.6 GLAZING ACCESSORIES

- A. Provide glazing gaskets, glazing sealants, glazing tapes, setting blocks, spacers, edge blocks, and other glazing accessories that are compatible with glazing products and each other and are approved by testing agencies that listed and labeled fire-resistant glazing products with which products are used for applications and fire-protection ratings indicated.
- B. Glazing Sealants for Fire-Rated Glazing Products: Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class 50, Use NT. Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated.
 - 1. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - 2. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range of industry colors.
- C. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
 - 1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 - 2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- D. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
 - 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
 - 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.7 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- C. Perimeter Insulation for Fire-Resistance-Rated Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.8 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with manufacturing and installation tolerances, including those for size, squareness, and offsets at corners, and for compliance with minimum required face and edge clearances.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate fire side and protected side. Label or mark units as needed so that fire side and protected side are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

- A. Use methods approved by testing agencies that listed and labeled fire-resistant glazing products.

- B. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publications.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than **50 inches (1270 mm)**.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide **1/8-inch- (3-mm-)** minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.
- I. Set glass lites with proper orientation so that coatings face fire side or protected side as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended in writing by gasket manufacturer.

3.4 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

- B. Insert soft compression gasket between glass and frame or fixed stop, so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- D. Install gaskets so they protrude past face of glazing stops.

3.5 CLEANING AND PROTECTION

- A. Immediately after installation, remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088813

SECTION 088853 - SECURITY GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Glass-clad polycarbonate security glazing.

1.2 DEFINITIONS

- A. Glazing Manufacturers: Firms that produce primary glass, monolithic plastic glazing, or fabricated security glazing, as defined in referenced glazing publications.
- B. Interspace: Space between lites of air-gap security glazing or insulating security glazing.

1.3 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on security glazing, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of glass coating.
- C. Samples for Verification:
 - 1. Glazing: Actual sample of finished products for each type of security glazing.
 - a. Size: Manufacturers' standard size.
- D. Security Glazing Schedule: List security glazing types and thicknesses for each size opening and location. Use same designations indicated on Drawings. Indicate coordinated dimensions of security glazing and construction that receives security glazing, including clearances and glazing channel dimensions.
- E. Delegated Design Submittal: For security glazing, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- F. Sustainable Design Submittals:
 - 1. Product Data: For sealants, indicating VOC content.

2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports:

- a. For each type of security glazing, for tests performed by qualified testing agency.
- b. For each type of glazing sealant, for tests performed by a qualified testing agency.

- 1) Provide test reports based on testing current sealant formulations within previous 36-month period.

B. Qualification Statements: For installers and manufacturers of insulating or air-gap security glazing with sputter-coated, low-e coatings.

C. Delegated design engineer qualifications.

D. Sample warranties.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: For insulating or air-gap security glazing units with sputter-coated, low-e coatings, a qualified insulating glazing manufacturer who is approved by coated-glass manufacturer.
2. Installers: Entity that employs installers and supervisors who are trained and approved by manufacturer.
3. Delegated Design Engineer: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of type indicated.
4. Security Glazing Testing Agency: Subject to compliance with requirements, testing agency is one of the following:
 - a. Intertek.
 - b. Underwriters Laboratories, Inc.
 - c. Wiss, Janney, Elstner Associates, Inc.
5. Sealant Testing Agency: An independent testing agency qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect security glazing and glazing materials according to manufacturer's written instructions. Prevent damage from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating security glazing and with air-gap security glazing manufacturers' written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

1.9 WARRANTY

- A. Special Warranty, Coated Glass: Manufacturer agrees to replace coated glass that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Defects developed in coated glass from normal use that is not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
 - 2. Warranty Period: 10 years from date of Substantial Completion.
- B. Special Warranty, Laminated-Polycarbonate Security Glazing: Manufacturer agrees to replace laminated-polycarbonate security glazing that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Defects developed from normal use that are not attributed to maintaining and cleaning laminated-polycarbonate security glazing contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced standard, yellowing, and loss of light transmission.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

- C. Special Warranty, Laminated-Glass and -Polycarbonate Security Glazing: Manufacturer agrees to replace laminated-glass and -polycarbonate security glazing that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - 2. Defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated-glass and -polycarbonate security glazing contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced polycarbonate standard, yellowing, and loss of light transmission.
 - 3. Warranty Period: 10 years from date of Substantial Completion.

- D. Special Warranty, Insulating Security Glazing: Manufacturer agrees to replace insulating security glazing that fails in materials and workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Defects in individual lites developed from normal use or failure of hermetic seal under normal use. Defects in individual lites or failure of hermetic seal that is attributed to glass breakage or to maintaining and cleaning insulating security glazing contrary to manufacturer's written instructions are not included.
 - b. Defects in coated-glass lites include peeling, cracking, and other indications of deterioration in coating.
 - c. Defects in laminated-glass lites include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 - d. Defects in glass-clad polycarbonate lites include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced glass-clad polycarbonate standard, yellowing, and loss of light transmission.
 - e. Evidence of hermetic seal failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glazing.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of security glazing from single source from single manufacturer.
 - 1. Obtain coated glass from single source from single manufacturer.
- B. Obtain glazing sealants and gaskets from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General:

1. Installed security glazing will withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or breakage attributable to defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
2. Installed security glazing will withstand security-related loads and forces without damage to the glazing beyond that allowed by referenced standards.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design security glazing.

C. Structural Performance: Glazing will withstand the following design loads within limits and under conditions indicated.

1. Design Procedure for Glass: ASTM E1300 and the IBC.
2. Design Wind Pressures: As indicated on Drawings.

a. Wind Design Data: As indicated on Drawings.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

E. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

F. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

2.3 SECURITY GLAZING, GENERAL

A. Glazing Publications: Comply with published recommendations of security glazing and glazing material manufacturers and organizations below unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. AAMA Publications: AAMA GDSG-1 and AAMA TIR-A7.
2. IGMA Publication for Insulating Glass: SIGMA TM-3000.
3. NGA Publications: "Laminated Glazing Reference Manual" and "GANA Glazing Manual."

B. Plastic Glazing Labeling: Identify plastic sheets with appropriate markings of applicable testing and inspecting agency, indicating compliance with required fire-test-response characteristics.

C. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction. Label will indicate manufacturer's name, type of glazing, glass thickness, and safety glazing standard with which glazing complies.

- D. Insulating Glazing Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the Insulating Glass Certification Council.
- E. Fire-Test-Response Characteristics of Polycarbonate Sheets: As determined by testing polycarbonate sheets identical to those used in security glazing products by a qualified testing agency acceptable to authorities having jurisdiction.
 - 1. Self-ignition temperature of 650 deg F (343 deg C) or more when tested in accordance with ASTM D1929 on plastic sheets in thicknesses indicated for the Work.
 - 2. Smoke-Developed Index of 450 or less when tested in accordance with ASTM E84 or UL 723, or smoke density of 75 or less when tested in accordance with ASTM D2843 on plastic sheets in thicknesses indicated for the Work.
 - 3. Burning extent of 1 inch (25 mm) or less when tested in accordance with ASTM D635 at a nominal thickness of 0.060 inch (1.52 mm) or thickness indicated for the Work.
- F. Thermal and Optical Performance Properties: Provide security glazing with performance properties specified, as indicated in manufacturer's published test data, based on construction products indicated and on procedures indicated below:
 - 1. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
 - 2. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW 7.7 computer program.
 - 3. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

2.4 GLASS PRODUCTS

- A. Float Glass: ASTM C1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- B. Heat-Treated Float Glass: ASTM C1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
 - 2. For heat-strengthened float glass, comply with requirements for Kind HS.
 - 3. For fully tempered float glass, comply with requirements for Kind FT.
 - 4. For uncoated glass, comply with requirements for Condition A.
 - 5. For coated vision glass, comply with requirements for Condition C (other coated glass).

2.5 LAMINATED-GLASS SECURITY GLAZING

- A. Laminated-Glass Security Glazing: ASTM C1172. Two or more glass lites bonded with interlayer. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
2. Interlayer Color: Clear unless otherwise indicated.

2.6 POLYCARBONATE SECURITY GLAZING

- A. Laminated-Polycarbonate Security Glazing: Two or more polycarbonate sheets bonded with clear urethane interlayer that complies with ASTM C1349, Appendix X2, and has a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation. Provide laminated units that comply with requirements of ASTM C1349 for maximum allowable laminating process blemishes and haze.
- B. Laminated Glass and Polycarbonate: ASTM C1349. Two or more glass lites and polycarbonate bonded with interlayer. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

2.7 INSULATING SECURITY GLAZING

- A. Insulating Security Glazing: Factory-assembled units, consisting of sealed lites of glazing material indicated separated by a dehydrated interspace, qualified in accordance with ASTM E2190
 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
 2. Spacer: Manufacturer's standard spacer material and construction.
 3. Desiccant: Molecular sieve or silica gel, or blend of both.

2.8 SPALL-RESISTANT FILM

- A. Composite of clear polyvinyl butyral film and clear abrasion-resistant polyester film.
- B. Laminating Process: Factory laminate spall-resistant film to glazing assemblies to produce laminated lites free of foreign substances, air, and glass pockets.

2.9 GLAZING SEALANTS

- A. General:
 1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they contact, including security glazing, seals of insulating security glazing and air-gap security glazing, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 2. Suitability: Comply with sealant and security glazing manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

3. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range of Industry colors.

B. Glazing Sealant:

1. Neutral-Curing Silicone Glazing Sealant, Class 100/50: Complying with ASTM C920, Type S, Grade NS, Use NT.

C. Security Sealant: Manufacturer's standard, nonsag, tamper-resistant sealant for joints with low movement complying with ASTM C920, Grade NS, Class 12.5 or 25, Use NT, and with a Shore A hardness of at least 45 when tested in accordance with ASTM C661.

2.10 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and security glazing manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:

1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.11 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by manufacturers of security glazing and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks:

1. Silicone with Shore A durometer hardness of 85, plus or minus 5.
2. Type recommended in writing by sealant or glass manufacturer.

D. Spacers:

1. Neoprene blocks or continuous extrusions of hardness required by security glazing manufacturer to maintain security glazing lites in place for installation indicated.
2. Type recommended in writing by sealant or security glazing manufacturer.

E. Edge Blocks:

1. Silicone with Shore A durometer hardness in accordance with manufacturer's written instructions.
2. Type recommended in writing by sealant or security glazing manufacturer.

F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.12 FABRICATION OF SECURITY GLAZING

- A. Fabricate security glazing in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Grind smooth and polish exposed security glazing edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing for security glazing, with Installer present, for compliance with the following:
 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 2. Presence and functioning of weep system.
 3. Minimum required face or edge clearances.
 4. Minimum required bite.
 5. Effective sealing between joints of framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving security glazing immediately before glazing. Remove coatings not firmly bonded to substrates.

- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of security glazing, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect edges of security glazing from damage during handling and installation. Remove damaged security glazing from Project site and legally dispose of it off Project site. Damaged security glazing includes units with edge or face damage or other imperfections that, when installed, could weaken security glazing and impair performance and appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glazing unit manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by security glazing manufacturers for installing lites.
- F. Provide spacers for security glazing lites where the length plus width is larger than **50 inches (1270 mm)**.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of security glazing. Install correct size and spacing to preserve required face clearances unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with performance requirements.
 - 2. Provide **1/8-inch (3-mm)** minimum bite of spacers on glazing lites and use thickness equal to sealant width. With glazing tape, use thickness of slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent security glazing from moving sideways in glazing channel, as recommended in writing by security glazing manufacturer and in accordance with requirements in referenced glazing publications.
- H. Set security glazing in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set coated security glazing with proper orientation so that coatings and films face exterior or interior as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended in writing by gasket manufacturer.

3.4 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended in writing by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glazing unit and frame or fixed stop, so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center security glazing in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in security glazing. Seal gasket joints with sealant recommended in writing by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center security glazing in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in security glazing. Seal gasket joints with sealant recommended in writing by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.5 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between security glazing and glazing stops to maintain face clearances and to prevent sealant from extruding into glazing channel and blocking weep systems. Secure spacers, or spacers and backings, in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to security glazing and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from security glazing.

3.6 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect security glazing from contact with contaminating substances resulting from construction operations, including weld splatter. Examine security glazing surfaces adjacent to or below

exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do contact with security glazing, remove substances immediately as recommended in writing by security glazing manufacturer. Remove and replace security glazing that cannot be cleaned without damage.
- C. Wash security glazing on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash security glazing as recommended in writing by security glazing manufacturer.

3.7 GLASS-CLAD POLYCARBONATE SECURITY GLAZING SCHEDULE (inner vestibule)

- A. Security Glazing Type SG-1: Clear symmetrical glass-clad polycarbonate.
1. Basis-of-Design Product: Insul-Gard Armor-Gard BALULN25
 2. Ballistic Resistance, UL 752: Level 3 in accordance with UL 752.
 3. Maximum Overall Unit Thickness: 1.01”
 4. Overall Visible Light Transmittance: 77%
 5. Provide safety glazing labeling.

END OF SECTION 088853

SECTION 090561.13 - MOISTURE VAPOR EMISSION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fluid-applied, resin-based, membrane-forming systems that control the moisture-vapor-emission rate of high-moisture, interior concrete to prepare it for floor covering installation.

1.3 ALLOWANCES

- A. Concrete MVE-control systems are part of Moisture Vapor Emission Control Allowance.

1.4 UNIT PRICES

- A. Work of this Section is affected by Moisture Vapor Emission Control Unit Price.

1.5 DEFINITIONS

- A. MVE: Moisture vapor emission.
- B. MVER: Moisture vapor emission rate.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. **Product Data:** For coatings, indicating VOC content.
 - 2. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each MVE-control system, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Preinstallation testing reports.
- D. Field quality-control reports.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Employs factory-trained personnel who are available for consultation and Project-site inspection.
- B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating directions for storage and mixing with other components.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Comply with MVE-control system manufacturer's written instructions for substrate and ambient temperatures, humidity, ventilation, and other conditions affecting system installation.
 - 1. Store system components in a temperature-controlled environment and protected from weather and at ambient temperature of not less than 65 deg F (18 deg C) and not more than 85 deg F (29.4 deg C) at least 48 hours before use.
 - 2. Maintain ambient temperature and relative humidity in installation areas within range recommended in writing by MVE-control system manufacturer, but not less than 65 deg F (18 deg C) or more than 85 deg F (29.4 deg C) and not less than 40 or more than 60 percent relative humidity, for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.
 - 3. Install MVE-control systems where concrete surface temperatures will remain a minimum of 5 deg F (3 deg C) higher than the dew point for ambient temperature and relative humidity conditions in installation areas for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. MVE-Control System Capabilities: Capable of suppressing MVE without failure where installed on concrete that exhibits the following conditions:
1. MVER: Maximum **25 lb of water/1000 sq. ft. (11.34 kg of water/92.9 sq. m)** when tested according to ASTM F1869.
 2. Relative Humidity: Maximum 90 percent when tested according to ASTM F2170 using in situ probes.
- B. Water-Vapor Transmission: Through MVE-control system, maximum **0.06 perm (3.45 ng/Pa x s x sq. m)** when tested according to ASTM E96/E96M.
- C. Tensile Bond Strength: For MVE-control system, greater than **200 psi (1.38 MPa)** with failure in the concrete according to ASTM D7234.

2.2 MVE-CONTROL SYSTEM

- A. MVE-Control System: ASTM F3010-qualified, fluid-applied, two-component, epoxy-resin, membrane-forming system; formulated for application on concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
1. Substrate Primer: Provide MVE-control system manufacturer's concrete-substrate primer if required for system indicated by substrate conditions.
 2. Cementitious Underlayment Primer: If required for subsequent installation of cementitious underlayment products, provide MVE-control system manufacturer's primer to ensure adhesion of products to MVE-control system.
 3. **VOC Content**: Provide coating with VOC content of 100 g/L or less.
 4. Low-Emitting Materials: Verify coating complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.3 ACCESSORIES

- A. Patching and Leveling Material: Moisture-, mildew-, and alkali-resistant product recommended in writing by MVE-control system manufacturer and with minimum of [**3000-psi (20.68-MPa)**] **<Insert pressure>** compressive strength after 28 days when tested according to ASTM C109/C109M.
- B. Crack-Filling Material: Resin-based material recommended in writing by MVE-control system manufacturer for sealing concrete substrate crack repair.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of system indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Preinstallation Testing:
 - 1. Testing Agency: Owner will engage a qualified testing agency to perform tests.
 - 2. Alkalinity Testing: Perform pH testing according to ASTM F710. Install MVE-control system in areas where pH readings are less than 7.0 and in areas where pH readings are greater than 8.5.
 - 3. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft. (304.8 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Internal Relative Humidity Test: Using in situ probes, ASTM F2170. Install MVE-control system in locations where concrete substrates exhibit relative humidity level greater than 75 percent.
 - 4. Tensile-Bond-Strength Testing: For typical locations indicated to receive installation of MVE-control system, install minimum 100-sq. ft. (9.29-sq. m) area of MVE-control system to prepared concrete substrate and test according to ASTM D7234.
 - a. Proceed with installation only where tensile bond strength is greater than 200 psi (1.38 MPa) with failure in the concrete.
- B. Concrete Substrates: Prepare and clean substrates according to MVE-control system manufacturer's written instructions to ensure adhesion of system to concrete.
 - 1. Remove coatings and other substances that are incompatible with MVE-control system and that contain soap, wax, oil, or silicone, using mechanical methods recommended in writing by MVE-control system manufacturer. Do not use solvents.
 - 2. Provide concrete surface profile complying with ICRI 310.2R CSP 3 by shot blasting using apparatus that abrades the concrete surface with shot, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
 - 3. After shot blasting, repair damaged and deteriorated concrete according to MVE-control system manufacturer's written instructions.
 - 4. Protect substrate voids and joints to prevent resins from flowing into or leaking through them.
 - 5. Fill surface depressions and irregularities with patching and leveling material.

6. Fill surface cracks, grooves, control joints, and other nonmoving joints with crack-filling material.
 7. Allow concrete to dry, undisturbed, for period recommended in writing by MVE-control system manufacturer after surface preparation, but not less than 24 hours.
 8. Before installing MVE-control systems, broom sweep and vacuum prepared concrete.
- C. Protect walls, floor openings, electrical openings, door frames, and other obstructions during installation.

3.3 INSTALLATION

- A. Install MVE-control system according to ASTM F3010 and manufacturer's written instructions to produce a uniform, monolithic surface free of surface deficiencies such as pin holes, fish eyes, and voids.
1. Install primers as required to comply with manufacturer's written instructions.
- B. Do not apply MVE-control system across substrate expansion, isolation, and other moving joints.
- C. Apply system, including component coats if any, in thickness recommended in writing by MVE-control system manufacturer for MVER indicated by preinstallation testing.
- D. Cure MVE-control system components according to manufacturer's written instructions. Prevent contamination or other damage during installation and curing processes.
- E. After curing, examine MVE-control system for surface deficiencies. Repair surface deficiencies according to manufacturer's written instructions.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform installation inspections.
- B. Installation Inspections: Inspect substrate preparation and installation of system components to ensure compliance with manufacturer's written instructions and to ensure that a complete MVE-control system is installed without deficiencies.
1. Verify that surface preparation meets requirements.
 2. Verify that component coats and complete MVE-control-system film thicknesses comply with manufacturer's written instructions.
 3. Verify that MVE-control-system components and installation areas that evidence deficiencies are repaired according to manufacturer's written instructions.
- C. MVE-control system will be considered defective if it does not pass inspections.

3.5 PROTECTION

- A. Protect MVE-control system from damage, wear, dirt, dust, and other contaminants before floor covering installation. Use protective methods and materials, including temporary coverings, recommended in writing by MVE-control system manufacturer.
- B. Do not allow subsequent preinstallation examination and testing for floor covering installation to damage, puncture, or otherwise compromise the MVE-control system membrane.

END OF SECTION 090561.13

SECTION 092116.23 - GYPSUM BOARD SHAFT WALL ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Gypsum board shaft wall assemblies.

1.3 ACTION SUBMITTALS

- A. Product Data: For each component of gypsum board shaft wall assembly.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. <Double click to insert sustainable design text for regional materials.>

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and support them on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with gypsum-shaftliner-board manufacturer's written instructions.
- B. Do not install finish panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, or mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E90 and classified according to ASTM E413 by a testing and inspecting agency.
- C. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 10 percent.
- D. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- E. Regional Materials: Manufacture products within **100 miles (160 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles (160 km)** of Project site.

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

- A. Fire-Resistance Rating: As indicated on Drawings 1 hour.
- B. STC Rating: 51, minimum.
- C. Gypsum Shaftliner Board:
 - 1. Type X: ASTM C1396/C1396M; manufacturer's proprietary fire-resistive liner panels with paper faces, **1 inch (25.4 mm)** thick, with double beveled long edges.
 - 2. Moisture- and Mold-Resistant Type X: ASTM C1396/C1396M; manufacturer's proprietary fire-resistive liner panels with ASTM D3273 mold-resistance score of 10 as rated according to ASTM D3274, **1 inch (25.4 mm)** thick, and with double beveled long edges.
 - a.
- D. Non-Load-Bearing Steel Framing, General: Complying with ASTM C645 requirements for metal unless otherwise indicated and complying with requirements for fire-resistance-rated assembly indicated.
 - 1. Protective Coating: ASTM A653/A653M, **G40 (Z120)**, hot-dip galvanized unless otherwise indicated.
- E. Studs: Manufacturer's standard profile for repetitive, corner, and end members as follows:

1. Depth: 2-1/2 inches (64 mm).
 2. Minimum Base-Metal Thickness: 0.030 inch (0.75 mm).
- F. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches (51 mm) long and matching studs in depth.
1. Minimum Base-Metal Thickness: Matching steel studs.
- G. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- H. Finish Panels: Gypsum board as specified in Section 092900 "Gypsum Board."
- I. Sound Attenuation Blankets: As specified in Section 092900 "Gypsum Board."

2.3 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with shaft wall manufacturer's written instructions.
- B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in Section 092900 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written instructions for application indicated.
- C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
- D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
1. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E488/E488M conducted by a qualified testing agency.
 2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E1190 conducted by a qualified testing agency.
- E. Reinforcing: Galvanized-steel reinforcing strips with 0.033-inch (0.84-mm) minimum thickness of base metal (uncoated).
- F. Acoustical Sealant: Section 079219 "Acoustical Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated and manufacturer's written installation instructions.
- B. Do not bridge building expansion joints with shaft wall assemblies; frame both sides of expansion joints with furring and other support.
- C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.
- D. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons and floor indicators, and similar items.
- E. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels while maintaining continuity of fire-rated construction.
- F. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- G. Sound-Rated Shaft Wall Assemblies: Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly.
- H. Installation Tolerance: Install each framing member so fastening surfaces vary not more than **1/8 inch (3 mm)** from the plane formed by faces of adjacent framing.

3.3 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

- B. Remove and replace panels that are wet, moisture damaged, or mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092116.23

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions.
2. Suspension systems for interior ceilings and soffits.
3. Grid suspension systems for gypsum board ceilings.

B. Related Requirements:

1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; and roof rafters and ceiling joists.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. **Product Data:** For recycled content, indicating postconsumer and preconsumer recycled content and cost.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

B. Evaluation Reports: For steel studs and tracks firestop tracks, post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.4 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association, or the Steel Stud Manufacturers Association.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Notify manufacturer of damaged materials received prior to installation.

- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.
- C. Horizontal Deflection: For composite wall assemblies, limited to 1/360 of the wall height based on horizontal loading of 5 lbf/sq. ft. (239 Pa).
- D. Design framing systems in accordance with AISI S220, "North American Specification for the Design of Cold-Formed Steel Framing - Nonstructural Members," unless otherwise indicated.
- E. Design Loads: As indicated on architectural Drawings or 5 lbf/sq. ft. (239 Pa) minimum as required by the IBC.
- F. Design framing systems to accommodate deflection of primary building structure and construction tolerances and to withstand design loads with a maximum deflection of <Insert inches (mm)>.

2.2 FRAMING SYSTEMS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Framing Members, General: Comply with ASTM C645 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C645 requirements for metal unless otherwise indicated
 - 2. Protective Coating: Comply with ASTM C645; ASTM A653/A653M, G40 (Z120); or coating with equivalent corrosion resistance. Galvannealed products are unacceptable.
 - a. Coating demonstrates equivalent corrosion resistance with an evaluation report acceptable to authorities having jurisdiction.

- C. Studs and Track: ASTM C645.
 - 1. Minimum Base-Steel Thickness: 0.0329 inch (0.836 mm).
 - 2. Depth: As indicated on Drawings.
- D. Slip-Type Head Joints: Where indicated, provide[**one of**] the following:
 - 1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to tracks while allowing 2-inch (51-mm) minimum vertical movement.
 - 2. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- E. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 - 1. Minimum Base-Steel Thickness: 0.0329 inch (0.836 mm).
- G. Cold-Rolled Channel Bridging: Steel, 0.0538-inch (1.367-mm) minimum base-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
 - 1. Depth: 1-1/2 inches (38 mm).
 - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.
- H. Hat-Shaped, Rigid Furring Channels: ASTM C645.
 - 1. Minimum Base-Steel Thickness: 0.0329 inch (0.836 mm).
 - 2. Depth: 7/8 inch (22.2 mm).
- I. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.
 - 1. Configuration: Asymmetrical or hat shaped.
- J. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
 - 1. Depth: 3/4 inch (19 mm).
 - 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch (0.8 mm).
 - 3. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- B. Hanger Attachments to Concrete:

1. Power-Actuated Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.
- D. Flat Hangers: Steel sheet, 1 by 3/16 inch (25 by 5 mm) by length indicated.
- E. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch (1.367 mm) and minimum 1/2-inch- (13-mm-) wide flanges.
 1. Depth: 2-1/2 inches (64 mm).
- F. Furring Channels (Furring Members):
 1. Cold-Rolled Channels: 0.0538-inch (1.367-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
 2. Steel Studs and Tracks: ASTM C645.
 - a. Minimum Base-Steel Thickness: 0.0329 inch (0.836 mm).
 - b. Depth: 2-1/2 inches (64 mm).
 3. Hat-Shaped, Rigid Furring Channels: ASTM C645, 7/8 inch (22 mm) deep.
 - a. Minimum Base-Steel Thickness: 0.0329 inch (0.836 mm).
 4. Resilient Furring Channels: 1/2-inch- (13-mm-) deep members designed to reduce sound transmission.
 - a. Configuration: Asymmetrical or hat shaped.

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide the following:
 1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
 - 2. Multilayer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
 - 3. Tile Backing Panels: 16 inches (406 mm) o.c. unless otherwise indicated.

- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum **1/2-inch (13-mm)** clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 - 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
 - 6. Curved Partitions:
 - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs **6 inches (150 mm)** o.c.
- E. Direct Furring:
 - 1. Screw to wood framing.
 - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced **24 inches (610 mm)** o.c.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than **1/8 inch (3 mm)** from the plane formed by faces of adjacent framing.

3.5 INSTALLING CEILING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Hangers: **48 inches (1219 mm)** o.c.
 - 2. Carrying Channels (Main Runners): **48 inches (1219 mm)** o.c.
 - 3. Furring Channels (Furring Members): **16 inches (406 mm)** o.c.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 - 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 5. Do not attach hangers to steel roof deck.
 - 6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 - 7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 - 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- F. Installation Tolerances: Install suspension systems that are level to within **1/8 inch in 12 feet (3 mm in 3.6 m)** measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

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END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.

B. Related Requirements:

1. Section 061600 "Sheathing" for gypsum sheathing for exterior walls.
2. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
3. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
4. Section 093013 "Ceramic Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Gypsum board, Type X.
2. Abuse-resistant gypsum board.
3. Impact-resistant gypsum board.
4. Mold-resistant gypsum board.
5. Cementitious backer units.
6. Water-resistant gypsum backing board.
7. Interior trim.
8. Joint treatment materials.
9. Laminating adhesive.
10. Sound-attenuation blankets.
11. Acoustical sealant.

B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.

C. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.

D. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. <Double click to insert sustainable design text for regional materials.>
3. Product Data: For adhesives and sealants, indicating VOC content.
4. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For ceiling and wall materials, indicating compliance with requirements for low-emitting materials.

1.3 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.4 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of gypsum panel and joint finishing material from single source with resources to provide products of consistent quality in appearance and physical properties.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Certaiteed: SAINT-GOBAIN.
 - 2. Georgia-Pacific Gypsum LLC.
 - 3. Gold Bond Building Products, LLC provided by National Gypsum Company.
 - 4. USG Corporation.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.
- C. Verify ceiling and wall materials comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.3 GYPSUM BOARD, GENERAL

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.

- B. **Regional Materials:** Manufacture products within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.
- C. **Size:** Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.4 INTERIOR GYPSUM BOARD

- A. Gypsum Board, Type X: ASTM C1396/C1396M.
 - 1. Thickness: 5/8 inch.
 - 2. Long Edges: Tapered.
- B. Abuse-Resistant Gypsum Board: ASTM C1396/C1396M gypsum board, tested according to ASTM C1629/C1629M.
 - 1. Core: 5/8 inch, Type X.
 - 2. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds [Level 1] [Level 2] [Level 3] requirements.
 - 3. Indentation: ASTM C1629/C1629M, meets or exceeds [Level 1] [Level 2] [Level 3] requirements.
 - 4. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds [Level 1] [Level 2] [Level 3] requirements.
 - 5. Long Edges: Tapered.
 - 6. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.
- C. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.
 - 1. Core: 5/8 inch, Type X.
 - 2. Long Edges: Tapered.
 - 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.5 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.
 - 1. Thickness: 5/8 inch.
 - 2. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.
- B. Water-Resistant Gypsum Backing Board: ASTM C1396/C1396M, with manufacturer's standard edges.
 - 1. Core: 5/8 inch, Type X.

2.6 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.
 - 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
 - 2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. L-Bead: L-shaped; exposed long flange receives joint compound.
 - d. U-Bead: J-shaped; exposed short flange does not receive joint compound.

- e. Expansion (control) joint.

2.7 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
 - 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
 - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
 - 5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.
- D. Joint Compound for Tile Backing Panels:
 - 1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
 - 2. Cementitious Backer Units: As recommended by backer unit manufacturer.
 - 3. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.8 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
 - 1. Verify adhesives have a VOC content of 50 g/L or less.
 - 2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
 - 1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

2. **Recycled Content:** Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.
- E. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."
1. **Verify sealant has a VOC** content of 250 g/L or less.
 2. **Verify sealant complies with the** testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."
- G. Vapor Retarder: As specified in Section 072600 "Vapor Retarders."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION AND FINISHING OF PANELS, GENERAL

- A. Comply with ASTM C840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
1. Type X: Where required for fire-resistance-rated assembly, vertical surfaces unless otherwise indicated.
 2. Abuse-Resistant Type: Lower 6'-0" of wall unless noted otherwise.
 3. Mold-Resistant Type:
 - a. Bathroom, Restroom, and Toilet Rooms.
 - b. Janitor Closets, Custodial, and Housekeeping rooms.
 - c. At partition walls within 5' of a water fixture unless noted otherwise.
 - d. Ceiling and adjacent painted walls above showers or tubs.
- B. Single-Layer Application:
1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
 2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
 3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Multilayer Application:
1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum,

from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.

2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners.

- D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 INSTALLATION OF TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile, except showers. Install with 1/4-inch gap where panels abut other construction or penetrations.
- B. Cementitious Backer Units: ANSI A108.11, at showers and where indicated on Drawings.
- C. Water-Resistant Backing Board: Comply with manufacturer's written installation instructions, and install for shower ceiling, and painted walls in showers, with 1/4-inch gap where panels abut other construction or penetrations.
- D. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLATION OF TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 1. Cornerbead: Use at outside corners unless otherwise indicated.
 2. LC-Bead: Use at exposed panel edges.
 3. L-Bead: Use where indicated on Drawings.
 4. U-Bead: Use at exposed panel edges.

3.6 FINISHING OF GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: Panels that are substrate for tile.
 - 3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - 4. Level 5: [**Where indicated on Drawings**] <Insert locations>.
- E. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.
- F. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Ceramic tile.
 2. Waterproof membrane.
 3. Crack isolation membrane.
 4. Metal edge strips.
 5. Marble thresholds.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples:
1. Full size sample of each type and composition of tile and for each color and finish required.
 2. For ceramic mosaic tile in color blend patterns, provide samples of each color blend.
 3. Trim selections.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Tile and Trim Units: Furnish quantity of full-size units equal to 2 percent of amount installed for each type, composition, color, pattern, and size indicated.

1.5 QUALITY ASSURANCE

- A. Flood Test: ASTM D5957-98, test waterproof membrane by plugging waste line with a test plug, fill the shower room with water, wait 24 hours and check for leaks. Provide a temporary dam at entry threshold.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build mockup of 8' x 10' wall and 8' x 10' flooring installation, where directed by Architect.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
 2. Obtain waterproof membrane, except for sheet products, from manufacturer of setting and grouting materials.

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide Standard-grade tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.3 TILE PRODUCTS

- A. Tile Basis of Design: Refer to product selections on Interior Finish Legend on Drawing ID001.

- B. Accessories: Provide accessories of type and size indicated, suitable for installing by same method as used for adjoining wall tile.
 - 1. Basis of Design: Prefabricated Schluter Kerdi-Board-SN recess with integral flanges, in each shower where indicated. Size: 12 x 12 x 3-1/2 inches deep unless noted otherwise.

2.4 THRESHOLDS

- A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
- B. Marble Thresholds: ASTM C503/C503M.
 - 1. Description:
 - a. Uniform, fine- to medium-grained white stone with gray veining.
 - b. Basis of Design: DalTile Double Hollywood Bevel marble threshold; 4" w x 36" l x 3/4" h.
 - 2. Locations: Thresholds to Rooms 209A and 210A.

2.5 TILE BACKING PANELS

- A. Cementitious Backer Units: Refer to Section 092900 – Gypsum Board Assemblies.

2.6 WATERPROOF MEMBRANE

- A. General: Manufacturer's standard product, selected from the following that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [ARDEX Americas.](#)
 - b. [Bonsal American, an Oldcastle company.](#)
 - c. [Custom Building Products.](#)
 - d. [LATICRETE SUPERCAP, LLC.](#)
 - e. [MAPEI Corporation.](#)

2.7 SETTING MATERIALS

- A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
 - 1. Cleavage Membrane: Asphalt felt, ASTM D226/D226M, Type I (No. 15); or polyethylene sheeting, ASTM D4397, 4.0 mils thick.
 - 2. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, 2 by 2 inches by 0.062-inch diameter; comply with ASTM A185/A185M and ASTM A82/A82M, except for minimum wire size.
 - 3. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.
- B. Modified Dry-Set Mortar (Thinset): ANSI A118.4.
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

- a. [Bonsal American, an Oldcastle company.](#)
 - b. [Bostik, Inc.](#)
 - c. [Custom Building Products.](#)
 - d. [LATICRETE SUPERCAP, LLC.](#)
 - e. [MAPEI Corporation.](#)
2. Provide prepackaged, dry-mortar mix combined with liquid-latex additive at Project site.
 3. For wall applications, provide nonsagging mortar.
- C. Improved Modified Dry-Set Mortar (Medium-set, large and heavy tile mortar): ANSI A118.15.
1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [ARDEX Americas.](#)
 - b. [Bonsal American, an Oldcastle company.](#)
 - c. [Custom Building Products.](#)
 - d. [H.B. Fuller Construction Products Inc. / TEC.](#)
 - e. [LATICRETE SUPERCAP, LLC.](#)
 - f. [MAPEI Corporation.](#)
 2. Provide prepackaged, dry-mortar mix combined with dry polymer additive at Project site.
 3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.15.
 4. Basis of Design: Ultraflex LFT by the MAPEI Corporation.

2.8 GROUT MATERIALS

- A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.
- B. Water-Cleanable Epoxy Grout: ANSI A118.3, with a VOC content of 65 g/L or less.
1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [ARDEX Americas.](#)
 - b. [Bostik; Arkema.](#)
 - c. [Custom Building Products.](#)
 - d. [Laticrete International, Inc.](#)
 - e. [MAPEI Corporation.](#)
 2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F, respectively, and certified by manufacturer for intended use.

2.9 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic, designed specifically for floor or wall applications.
1. Refer to Interior Finish Schedule for selections.

- C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.10 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - 3. Verify that recess in concrete substrates for tile floors installed with thickset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1B and is sloped 1/4 inch per foot toward drains.
- C. Waterproof Membrane: Install waterproofing over prepared substrates as follows:
 - 1. Shower Walls and Floors: Entire floor and full height of wall.
 - 2. Bathroom Walls: Extend up walls minimum of 4" where base is ceramic tile.
 - 3. Floors: Under floor tile in restrooms, bathrooms or any rooms exposed to water.
 - 4. Flood test waterproof membrane for 24 hours before installing tile.
- D. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from

other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 CERAMIC TILE INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 - 1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Tile floors in wet areas.
 - b. Tile floors consisting of tiles 8 by 8 inches or larger.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
- G. Joint Widths: Refer to joint width indicated on the Interior Finish Legend on Drawing ID001. Where width is not indicated install tile with the following joint widths:
- H. Metal Edge Strips: Install at the following locations:
 - 1. Floor Transition: Between tile and adjacent flooring material.
 - 2. Outside Corners: At all outside corners.
 - 3. Where noted in Interior Finish Schedule on Drawing ID001.
- I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- J. Install tile backing panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.

- K. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

3.4 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete Subfloor:
 - 1. Ceramic and Quarry Tile Installation: TCNA F113; thinset mortar.
 - a. Thinset Mortar: Modified dry-set mortar.
 - b. Grout: Epoxy grout.
 - 2. Marble Thresholds: Thinset mortar.
- B. Interior Wall Installations, Wood or Metal Studs or Furring:
 - 1. Ceramic Tile Installation: Thinset mortar on gypsum board.
 - a. Thinset Mortar: Improved modified dry-set mortar.
 - b. Grout: Epoxy grout.
- C. Shower Receptor and Wall Installations:
 - 1. Ceramic Tile Installation: TCNA B421 and ANSI A108.1B; thinset mortar on waterproof membrane over cement mortar bed (thickset) over vapor-retarder membrane.
 - a. Bond Coat for Cured-Bed Method: Modified dry-set or improved modified dry-set mortar for large format tile.
 - b. Thickset Mortar: Modified portland cement mortar. Slope to drain. Install reinforcing when area exceeds 65 s.f.
 - c. Waterproof membrane: Fluid applied membrane.
 - d. Thinset Mortar: Modified dry-set or improved modified dry-set mortar for large format tile.
 - e. Grout: Epoxy grout.

END OF SECTION 093013

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for interior ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.
- C. Samples: For each exposed product and for each color and texture specified, 6 inches in size.
- D. Samples for Initial Selection: For components with factory-applied finishes.
- E. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:
 - 1. Acoustical Panels: Set of 6-inch- square Samples of each type, color, pattern, and texture.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Ceiling suspension-system members.
 - 2. Structural members to which suspension systems will be attached.
 - 3. Method of attaching hangers to building structure.
 - a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
 - 4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
 - 5. Size and location of initial access modules for acoustical panels.
 - 6. Items penetrating finished ceiling and ceiling-mounted items including the following:
 - a. Lighting fixtures.
 - b. Diffusers.
 - c. Grilles.
 - d. Speakers.
 - e. Sprinklers.
 - f. Access panels.
 - g. Perimeter moldings.

7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
8. Minimum Drawing Scale: 1/4 inch = 1 foot.

B. Qualification Data: For testing agency.

C. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Evaluation Reports: For each acoustical panel ceiling suspension system, from ICC-ES.

E. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Units: 4 cases of each type panel installed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Verify ceiling products comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class A according to ASTM E1264.
 - 2. Smoke-Developed Index: 450 or less.

2.3 ACOUSTICAL PANELS (ACT-1 and ACT-2)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong Ceiling & Wall Solutions.
 - 2. Certainteed; SAINT-GOBAIN.
 - 3. USG Corporation.
- B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
 - 1. Basis of Design: Refer to Interior Finish Schedule for requirements.
- C. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

2.4 METAL SUSPENSION SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong Ceiling & Wall Solutions.
 - 2. Certainteed; SAINT-GOBAIN.
 - 3. USG Corporation.
- B. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C635/C635M and designated by type, structural classification, and finish indicated.
 - 1. High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" according to ASTM C635/C635M.
- C. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- D. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 15/16-inch- wide metal caps on flanges.
 - 1. Structural Classification: Heavy-duty system.
 - 2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
 - 3. Face Design: Flat, flush.
 - 4. Cap Material: Cold-rolled steel or aluminum.

5. Cap Finish: Painted white.
- E. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 9/16-inch- wide metal caps on flanges.
1. Structural Classification: Intermediate-duty system.
 2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
 3. Face Design: Flat, flush.
 4. Cap Material: Cold-rolled steel or aluminum.
 5. Cap Finish: Painted white.

2.5 ACCESSORIES

- A. Wire Hangers, Braces, and Ties: Provide wires as follows:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
 2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.106-inch- diameter wire.
- B. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- C. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- D. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch- thick, galvanized-steel sheet complying with ASTM A653/A653M, G90 coating designation; with bolted connections and 5/16-inch- diameter bolts.
- E. Hold-Down Clips: Manufacturer's standard hold-down.

2.6 METAL EDGE MOLDINGS AND TRIM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armstrong Ceiling & Wall Solutions.
 2. Certainteed; SAINT-GOBAIN.
 3. Gordon Inc.
 4. USG Corporation.
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
 2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
 3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

2.7 ACOUSTICAL SEALANT

- A. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

- A. Install acoustical panel ceilings according to ASTM C636/C636M and manufacturer's written instructions.
- B. Suspend ceiling hangers from building's structural members and as follows:
 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 8. Do not attach hangers to steel deck tabs.
 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
- C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- D. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- E. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.
1. Arrange directionally patterned acoustical panels as follows:
 - a. As indicated on reflected ceiling plans.
 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
 3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
 5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
 6. Install hold-down clips in areas indicated; space according to panel manufacturer's written instructions unless otherwise indicated.
 - a. Hold-Down Clips: Install on panels with 20 feet of an exterior door.

3.4 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.
- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

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PA-745-210-001

3.5 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096253 – SYNTHETIC TURF FLOORING

PART 1 – GENERAL

1.01 WORK

- A. Synthetic turf flooring for interior dog kennels.

1.02 REFERENCES

- A. ATSM Standard Test Methods
- D1577 – Standard Test Method for Linear Density of Textile Fiber
 - D5848 – Standard Test Method for Mass Per Unit Area of Pile Yarn Floor Covering
 - D418 – Standard Test Method for Testing Pile Yarn Floor Covering Construction
 - D1338 – Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings
 - D1682 – Standard Method of Test for Breaking Load and Elongation of Textile Fabrics
 - D5034 – Standard Test Method of Breaking Strength and Elongation of Textile Fabrics (Grab Test)
 - F1551 – Standard Test Methods for Water Permeability
 - D2859 – Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials
 - F355 – Standard Test Method for Shock-Absorbing Properties of Playing Surfaces
 - D1557 – Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
- B. STC Suggested Guidelines for the Essential Elements of Synthetic Turf Systems.

1.03 QUALITY CONTROL

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section. The Turf Manufacturer:
- B. Installer Qualifications: Company specializing in performing the work of this section.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include sheet flooring layouts, locations of seams, and edge terminations.
1. Submit a 1-lb sample of the selected bid infill material(s).

1.05 WARRANTY

- A. Provide 8 year warranty by the manufacturer, against defects in materials and workmanship.
- B. Warranty shall be for full replacement of any damaged product within the warranty period.

PART 2 PRODUCTS

2.01 TURF SYSTEM (STF-1)

- A. Basis of Design: Pet Heaven synthetic turf system by GrassTex (www.grass-tex.com).
- B. Turf Fiber:
1. Fiber Weight: ASTM D5848, 60 ounces per square yard.
 2. Thickness: ASTM D3218, 100 microns thick.

3. Tensile Strength: ASTM D3218, 71 N (PE Mono); 16 N (PP).
4. The turf fiber must contain less than 100 ppm of lead chromate in all colors.
5. The turf fibers must be from the same dye lots.
6. The turf fibers must be guaranteed for a period of Eight Years not to fade or fail (as distinguished from a change in texture) or have a pile height decrease to 50% of pile height as result of UV degradation.
7. The turf fiber must retain a minimum of 75% of its original fibril width after 10,000 cycles on the Lisport Studded Roll Test Machine.
8. The pile fabric shall possess the following physical characteristics

Characteristic	Value	Test
Finished Pile Height*	7/8" (22mm)	ASTM D 5823
Product Weight (total)*	89 oz./yd ²	ASTM D 3218
Primary Backing Weight*	7.4 oz./yd ²	ASTM D 2256
Secondary coating Weight**	22 oz./yd ²	ASTM D 5848
Fabric Width	15' (4.57m)	ASTM D 5793
Tuft Gauge	1/4"	ASTM D 5793
Grab Tear Strength	200-1b-F	ASTM D 5034
Tuft Bind	>10-1b-F	ASTM D 1335
Infill (Sand)	2 lbs Silica Sand	None
Infill (Rubber)	N/A	None
Except where noted as a minimum, the above specifications are nominal.		
* Values are +/- 5%. **All values are +/- 3 oz./yd ² .		

- C. Backing Material
 - a. Primary Backing: Dual layered woven polypropylene material, minimum of 7.0 ounces/square yard.
 - b. Secondary Backing: Minimum of 22 ounces/ square yard with drainage perforations of 3/16" to 1/4" diameter at 4 inches or less on center each way.
- D. Turf roll seams: Sewn or glued on site. All turf fabric edges to be securely bound as per the perimeter detail design.
- E. Seam Adhesive: Nordot 34G Glue, Mapei 2K, Turf Claw, hot melt technology.
- F. Fabric surface: shall be constructed and installed in minimum widths of 15 feet with no longitudinal or transverse seams.
- G. Flammability: Pass the DIN standard Pill Burn test or ASTM D 2859.

2.04 INFILL MATERIAL

- A. The synthetic infill material shall consist of a blend of graded, silica sand and treated and mixed ground rubber.
 1. Sand: specially-graded, dust-free silica sand shall be placed on the turf in a minimum quantity of 1 pound/ square foot and shall include test results that demonstrate the following minimum properties:
 - a. Color – tan
 - b. Sand shall be round non-angular in shape

- c. Roundness – 0.6+
 - d. Hardness - 0.6-0.8 on the Mohs Scale
 - e. Size – 1.00 mm ± 0.15 mm
 - f. Density – 90 – 95 lbs/ cu ft.
 - g. Dust - < 0.001 %
 - h. Angle of Repose - < 30°
 - i. Sand shall be heavy metal safe
2. Rubber: Rubber is SBR ambient (styrene butadiene rubber) rubber, color black, 10-18 mesh, that is 99% fiber free and is heavy metal safe. Rubber shall be placed on the turf in a minimum quantity as referenced the table in Section 2.02 in this document and shall be of the following Mesh Size Distribution:

Mesh Size	% Retained
a. 10	0-15%
b. 12	5-30%
a. 16	40-70%
b. 20	15-35%
c. 30	0-10%
d. 40	0-1%
e. Pan	0-1%

PART 3 EXECUTION

3.01 GENERAL

- A. Installation of the synthetic turf system is to comply with the manufacturer’s installation instructions and approved shop drawings.

3.02 PRODUCT DELIVERY, STORAGE & HANDLING

- A. Deliver products to site in original containers.
- B. Store products in a location and in a position that protects them from crush damage or any other defects.
- C. Handle and store (on and off site) all materials safely to ensure their physical properties are not adversely affected and that they are not subject to vandalism or damage.
- D. Rubber and sand infill shall arrive dry and loose.
- E. Adhesives shall arrive in dry, sealed containers.

3.03 TURF INSTALLATION

- A. Install synthetic turf system in accordance with the manufacturer’s written installation instructions.
- B. Turf shall be attached to the perimeter edge as shown in the construction plans and as per the manufacturer.
- C. All seams shall be brushed thoroughly before infill materials are installed.
- D. All terminations shall be as detailed and approved in the shop drawings.

3.04 INFILL INSTALLATION

- A. The synthetic turf shall be thoroughly brushed prior to installation of infill materials to remove wrinkles.
- B. Turf shall remain free draining at all times before, during and after the infill materials are installed.

3.05 CLEANING AND COMPLETION

- A. Protect installed work from other construction activities.
- B. Clean surfaces and site of all refuse resulting from the installation process.

END OF SECTION 096253

SECTION 096500 - RESILIENT FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Resilient base.
 2. Resilient tile flooring.
 3. Resilient stair accessories.
 4. Resilient molding accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
1. Product Data: For adhesives, indicating VOC content.
 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 3. Product Data: For chemical-bonding compounds, indicating VOC content.
 4. Laboratory Test Reports: For chemical-bonding compounds, indicating compliance with requirements for low-emitting materials.
 5. Product Data: For sealants, indicating VOC content.
 6. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
 7. Laboratory Test Reports: For flooring products, indicating compliance with requirements for low-emitting materials.
 8. Environmental Product Declaration: For each product.
 9. Health Product Declaration: For each product.
 10. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
- C. Shop Drawings: For each type of resilient flooring.
1. Tile: For each type of flooring. Include flooring layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 2. Sheet Material: For each type of flooring. Include flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 3. Show details of special patterns.
- D. Samples: For each exposed product and for each color, texture, and pattern specified, in manufacturer's standard size, but not less than 6-by-9-inch sections.
- E. Product Schedule: For flooring. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of flooring to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flooring: Furnish one box of each type, color, and pattern of flooring installed.
 - 2. Resilient Sheet Flooring: Furnish not less than 10 linear feet in roll form and in full roll width for each type, color, and pattern of flooring installed. Include weld-rod material.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for flooring installation and seaming method indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floorings on flat surfaces.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive flooring during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during flooring installation.
- D. Close spaces to traffic for 48 hours after flooring installation.
- E. Install flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient flooring, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- B. Verify flooring products comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 THERMOSET-RUBBER BASE (RB-1)

- A. Product Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
- B. Lengths: Coils in manufacturer's standard length.
- C. Inside and Outside Corners: Job formed.
- D. Basis-of-Design Product: Refer to Interior Finish Schedule on Drawing ID001 for selection.

2.3 LUXURY VINYL TILE (LVT-1)

- A. Product Standard: ASTM 1859.
- B. Basis-of-Design Product: Refer to Interior Finish Schedule on Drawing ID001 for selection.

2.4 VINYL ENHANCED TILE (RF-1)

- A. Product Standard: ASTM F1066.
- B. Basis-of-Design Product: Refer to Interior Finish Schedule on Drawing ID001 for selection.

2.5 RUBBER TILE (RT-1)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexco.
 - 2. Mannington Mills, Inc.
 - 3. Nora by Interface.
- B. Tile Standard: ASTM F1344.
- C. Basis-of-Design Product: Refer to Interior Finish Schedule on Drawing ID001 for selection.
- D. Accessory: Polish as recommended by manufacturer.

2.6 STAIR ACCESSORIES (ST-1)

- A. Stair Treads: ASTM F 2169.
 - 1. Size: Lengths and depths to fit each stair tread in one piece.
- B. Landing Tile: Matching treads; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.
- C. Basis of Design Product: Refer to Interior Finish Schedule on Drawing ID001 for selection

2.7 MOLDING ACCESSORIES

- A. Description: Transition strips for application between different flooring materials of different heights.

- B. Profile and Dimensions:
 - 1. General: As required for conditions encountered.
 - 2. Special Conditions: Refer to Interior Finish Schedule on Drawing ID001 for selection.
- C. Colors: As selected by Architect.

2.8 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by flooring manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit flooring and substrate conditions indicated.
 - 1. Verify adhesives have a VOC content of 50 g/L or less.
 - 2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Stair-Tread Nose Filler: Two-part epoxy compound recommended by resilient stair-tread manufacturer to fill nosing substrates that do not conform to tread contours.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of flooring.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to flooring manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by flooring manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 10 pH.
 - 4. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

- a. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floorings until materials are the same temperature as space where they are to be installed.
 1. At least 48 hours in advance of installation, move resilient flooring and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient flooring.

3.3 FLOOR TILE AND PLANK INSTALLATION

- A. Comply with manufacturer's written instructions for installing flooring.
- B. Lay out floorings from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 1. Lay tiles square with room axis.
- C. Match floorings for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 1. Lay tiles in pattern of colors and sizes indicated.
- D. Scribe, cut, and fit floorings to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floorings into toe spaces, door reveals, closets, and similar openings. Extend floorings to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floorings as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Adhere floorings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Form without producing discoloration (whitening) at bends.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Miter or cope corners to minimize open joints.

3.5 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Stair Accessories:
 - 1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
 - 2. Tightly adhere to substrates throughout length of each piece.
 - 3. For treads installed as separate, equal-length units, install to produce a flush joint between units.
- C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.6 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting flooring.
- B. Perform the following operations immediately after completing flooring installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Apply three coats of polish in accordance with manufacturer's instructions.
- D. Protect flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- E. Cover flooring until Substantial Completion.

END OF SECTION 096519

SECTION 096723 - RESINOUS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Resinous flooring systems.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.
- B. Sustainable Design Submittals:
1. Environmental Product Declaration: For each product.
 2. Health Product Declaration: For each product.
 3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
 4. Multi-Attribute Optimization: For each product, provide documentation of third-party certification, indicating impact reduction in global warming potential, depletion of stratospheric ozone layer, acidification of land and water sources, eutrophication, and/or formation of tropospheric ozone.
 5. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 6. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
 7. Supply Chain Optimization: For each product, provide documentation demonstrating that manufacturer practices comply with supply chain optimization requirements.
 8. Laboratory Test Reports: For flooring products, indicating compliance with requirements for low-emitting materials.
 9. Laboratory Test Reports: For finish system, indicating compliance with requirements for low-emitting materials.
 10. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Samples for Initial Selection: For each type of exposed finish required.
- D. Samples for Verification: For each resinous flooring system required, 6 inches square, applied to a rigid backing by Installer for this Project.

1.3 INFORMATIONAL SUBMITTALS

- A. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
- B. Material Certificates: For each resinous flooring component, from manufacturer.
- C. Material Test Reports: For each resinous flooring system, by a qualified testing agency.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.
- B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.
- C. Close spaces to traffic during resinous flooring application and for 24 hours after application unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Verify flooring products comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Flammability: Self-extinguishing according to ASTM D635.
- C. System Physical Properties: Provide resinous flooring system meeting the following minimum physical property requirements:
 - 1. VOC Content: 4 g/l per ASTM D-2369, Method E.
 - 2. Flammability: Class 1 per ASTM E-648.
 - 3. Compressive Strength: 10,000 minimum according to ASTM C579.
 - 4. Tensile Strength: 1750 minimum according to ASTM C307.
 - 5. Flexural Modulus of Elasticity: 2.0×10^6 psi minimum according to ASTM C580.
 - 6. Water Absorption: 0.2 percent maximum according to ASTM C413.
 - 7. Impact Resistance: >160 in/ lbs per ASTM D2794.
 - 8. Hardness: 85-90, Shore D according to ASTM D2240.

2.2 RESINOUS FLOORING (RES-1)

- A. Resinous Flooring System: Abrasion-, impact-, and chemical-resistant, aggregate-filled, and resin-based monolithic epoxy mortar system designed to produce a seamless floor and integral cove base.
 - 1. Basis of Design: Refer to Interior Finish Schedule on Drawing ID001.
- B. Waterproofing: Type recommended by resinous flooring manufacturer for substrate and resinous flooring system indicated.
- C. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.
- D. Body Coat:
 - 1. Material: Four component epoxy mortar system consisting of epoxy resin, amine curing agent, pigments and selected, graded aggregates.
 - 2. Formulation Description: 100 percent solids.
 - 3. Type: Pigmented.
 - 4. Application Method: Self-leveling slurry with broadcast aggregates.
 - 5. Number of Coats: Two.
 - 6. Thickness: 1/4 inch.
 - 7. Aggregates: Colored quartz (ceramic-coated silica).
 - 8. Basis of Design: StonClad GS by Stonehard.
- E. Topcoat:
 - 1. Resin: Epoxy.
 - 2. Formulation Description: 100 percent solids.
 - 3. Type: Clear.
 - 4. Number of Coats: Two.
 - 5. Thickness of Coats: 5 mil minimum dry film thickness, per coat.
 - 6. Finish: Gloss.
 - 7. Basis of Design: StoneKote HT4 by Stonehard.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry substrate for resinous flooring application.
- B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
 - 1. Roughen concrete substrates as follows:
 - a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
 - b. Comply with ASTM C811 requirements unless manufacturer's written instructions are more stringent.
 - 2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.

3. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
 - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. of slab area in 24 hours.
 4. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
- C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
- D. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

3.2 INSTALLATION

- A. Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
 2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
- B. Primer: Apply primer over prepared substrate at manufacturer's recommended spreading rate.
- C. Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details, including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.
1. Integral Cove Base: 4 inches high.
- D. Troweled or Screeded Body Coats: Apply troweled or screeded body coats in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When body coats are cured, remove trowel marks and roughness using method recommended by manufacturer.
- E. Topcoats: Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer and to produce wearing surface indicated.

3.3 PROTECTION

- A. Protect resinous flooring from damage and wear during the remainder of construction period.
- B. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 096723

SECTION 096813 - CARPET TILE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes modular carpet tile.
- B. Related Requirements:
 - 1. Section 096500 "Resilient Flooring" for resilient wall base and accessories installed with carpet tile.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
 - 2. Include manufacturer's written installation recommendations for each type of substrate.
- B. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 3. Laboratory Test Reports: For flooring products, indicating compliance with requirements for low-emitting materials
- C. Shop Drawings: For carpet tile installation, plans showing the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
 - 2. Carpet tile type, color, and dye lot.
 - 3. Pattern type, location, and direction.
 - 4. Pile direction.
 - 5. Type, color, and location of insets and borders.
 - 6. Type, color, and location of edge, transition, and other accessory strips.
 - 7. Transition details to other flooring materials.
- D. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet Tile: Full size sample.
- E. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
- F. Sustainable Product Certification: Provide ANSI/NSF 140 certification for carpet products.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

- B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.
- C. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Carpet Tile: 1 case of full-size tiles for each type and color used.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI's "CRI Carpet Installation Standard."

1.8 FIELD CONDITIONS

- A. Comply with CRI's "CRI Carpet Installation Standard" for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

1.9 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 - 2. Failures include, but are not limited to, the following:
 - a. More than 10 percent edge raveling, snags, and runs.
 - b. Dimensional instability.
 - c. Excess static discharge.
 - d. Loss of tuft-bind strength.
 - e. Loss of face fiber.

- f. Delamination.
- 3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE

- A. Carpet Tile: Refer to Interior Finish Schedule on Drawing ID001 for carpet tile Basis of Design selections.
- B. Sustainable Design Requirements:
 - 1. Sustainable Product Certification: Silver level certification according to ANSI/NSF 140.
 - 2. Verify flooring products comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Clear 3" x 3" polyester squares with colored print. Compounded acrylic adhesive, applied to PET polyester backing with PET polyester release liner.
 - 1. Basis of Design: TacTiles Connectors by Interface.
- C. Resilient Edge/Transition Strips: Refer to Section 096500.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
 - 1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Relative Humidity Test: Using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
 - b. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI's "Carpet Installation Standards" and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: Glue down; install every tile with releasable, pressure-sensitive TacTile connectors.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns indicated on Drawings.
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders.
- I. Access Flooring: Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet TacTile connectors.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.

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- B. Protect installed carpet tile to comply with CRI's "Carpet Installation Standard," Section 20, "Protecting Indoor Installations."

- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 096933 - LOW-PROFILE FIXED HEIGHT ACCESS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes low-profile, fixed-height access flooring.

1.2 COORDINATION

- A. Coordinate location of electrical work in underfloor cavity and wire management channels.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for low-profile, fixed-height access flooring.
 - 2. Include loading capacities.
- B. Sustainable Design Submittals:
 - 1. **Product Data:** For recycled content, indicating postconsumer and preconsumer recycled content and cost.
- C. Shop Drawings: For low-profile, fixed-height access flooring:
 - 1. Include layout of low-profile, fixed-height access flooring and relationship to adjoining Work based on field-verified dimensions.
 - 2. Details and sections with descriptive notes indicating materials, finishes, fasteners, typical and special edge conditions, accessories, and understructures.
- D. Samples:
 - 1. Exposed Metal Accessories: Approximately 10 inches in length.
 - 2. One full-size unit for each component of each type of low-profile, fixed-height access flooring required.
 - 3. Floor Coverings: Full-size units for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Low-Profile, Fixed-Height Access-Flooring Components: One of each type.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance:
 - 1. Loading Capacity: 100 lbs/ s.f. live load with the following deflection and permanent set:
 - a. Top-Surface Deflection: Maximum 0.15 inch.
 - b. Permanent Set: Maximum 0.06 inch.
- B. Fire Performance:
 - 1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 50 or less.
- C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.2 LOW-PROFILE, FIXED-HEIGHT ACCESS FLOORING

- A. Low-Profile, Fixed-Height Access Flooring: Manufacturer's standard, modular, steel components, designed to interconnect and provide channels for installation of wiring; with manufacturer's standard factory-applied finish.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Tate Access Flooring, Low FFH Bolted Stringer Model or comparable product by one of the following:
 - a. ASM Modular Systems, Inc.
 - b. Computer Environments Inc.
 - c. Global IFS.
 - 2. Module: Low-profile access flooring with nominal module size of 24 x 24 inches.
 - 3. Height: Low-profile access flooring with nominal height of 3 inches.
- B. Floor Panels: Panels shall consist of a top steel sheet welded to a formed steel bottom pan filled internally with lightweight cementitious material.
 - 1. Basis of Design: Tate Access Floors, Inc. ConCore 1500 Panels supported by the Posilock understructure system.
 - 2. Floor Finish: Coordinate and prepare flooring system to receive field-installed selected floor finish, including required any subfloor systems.
 - a. Coordinate with 096813- Carpet Tile.
- C. Pedestals:
 - 1. Pedestal assemblies shall be corrosive resistant, all steel welded construction.
 - 2. Pedestal head shall be designed with locating tabs and integral shape to interface with the panel for positive lateral retention.
 - 3. Hot-dip galvanized pedestal base assembly shall consist of a formed steel plate with minimum 16 inches of bearing area.
- D. Service Outlets and Wiring: Standard UL-listed and -labeled assemblies, for recessed mounting flush with top of floor panels; for power, communication, and signal services; and complying with the following requirements:

1. Cover and Box Type: Hinged polycarbonate cover with opening for passage of cables when cover is closed and including frame and steel box or formed-steel plate for mounting electrical receptacles.
 2. Receptacles and Wiring: Equip each service outlet with power receptacles to comply with the following requirements:
 - a. Type of Receptacle: Heavy-duty duplex, two-pole, three-wire grounding, 20 A, 125 V, NEMA WD 6, Configuration 5-20R unless otherwise indicated.
 - b. Number of Receptacles for Outlet: Four.
 - c. Wiring Method: Factory wired for field hardwiring with armored cable, containing three insulated No. 12 AWG solid-copper conductors, terminated with a 6 foot long pigtail.
- E. Fascia Closures: Where underfloor cavity is not enclosed by abutting walls or other construction, provide metal closure plates with manufacturer's standard finish.
- F. Perimeter Support: Manufacturer's standard method for supporting panel edge and forming transition between low-profile, fixed-height access flooring and adjoining floor coverings at same level as low-profile, fixed-height access flooring.

2.3 FABRICATION

- A. Fabrication Tolerances:
1. Size: Plus or minus 0.20 inch of required size.
 2. Flatness: Plus or minus 0.035 inch, measured on a diagonal on top of panel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer and manufacturer's authorized representative present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. Verify that substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of conditions and deleterious substances that might interfere with attachment of pedestals.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- B. Lay out low-profile access flooring installation to keep the number of cut panels at floor perimeter to a minimum. Avoid using panels cut to less than 6 inches.
- C. Complete any necessary subfloor preparation, and vacuum subfloor to remove dust, dirt, and construction debris before beginning installation.

3.3 INSTALLATION

- A. Install low-profile, fixed-height access flooring and accessories under supervision of low-profile, fixed-height access-flooring manufacturer's authorized representative to produce a rigid, firm installation that complies with performance requirements and is free of instability, rocking, rattles, and squeaks.
- B. Install flooring securely in place and properly seated, with panel edges flush. Do not force panels into place.
- C. Scribe perimeter panels to provide a close fit with adjoining construction, having no voids greater than 1/8 inch where panels abut vertical surfaces.

END OF SECTION 096933

SECTION 097200 - WALL COVERINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Vinyl wall covering.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each type of wall covering and for each color, pattern, texture, and finish specified, full width by 36-inch- long in size.

1.3 INFORMATIONAL SUBMITTALS

- A. Product test reports.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 50 or less.

2.2 VINYL WALL COVERING (WC-1 thru WC-2)

- A. Refer to Interior Finish Schedule on Drawing ID001 for basis of design.

2.3 ACCESSORIES

- A. Adhesive: Mildew-resistant, nonstaining, strippable adhesive, for use with specific wall covering and substrate application indicated and as recommended in writing by wall-covering manufacturer.
- B. Primer/Sealer: Mildew resistant, recommended in writing by primer/sealer and wall-covering manufacturers for intended substrate.

3.1 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, mildew, and incompatible primers.
- C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
 - 1. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.
 - 2. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
 - 3. Painted Surfaces: Treat areas susceptible to pigment bleeding.
- D. Check painted surfaces for pigment bleeding. Sand gloss, semigloss, and eggshell finish with fine sandpaper.
- E. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.
- F. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.2 WALL-COVERING INSTALLATION

- A. Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated.
- B. Cut wall-covering strips in roll number sequence. Change the roll numbers at partition breaks and corners.
- C. Install strips in same order as cut from roll.
- D. Install wall covering without lifted or curling edges and without visible shrinkage.
- E. Match pattern 72 inches above the finish floor.
- F. Install seams vertical and plumb at least 6 inches from outside corners and 3 inches from inside corners unless a change of pattern or color exists at corner. Horizontal seams are not permitted.
- G. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without overlaps or gaps between strips.
- H. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.
- I. Remove excess adhesive at seams, perimeter edges, and adjacent surfaces.
- J. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 097200

SECTION 098313 – ACOUSTIC WALL COATING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Decorative acoustic wall coating.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include manufacturer's technical data, application instructions, and recommendations for each acoustic wall coating component required.
- B. Samples for Initial Selection: For each type of exposed finish required.
- C. Samples for Verification: For each acoustic wall coating system required, 6 inches square, applied to a rigid backing by Installer for this Project.

1.3 INFORMATIONAL SUBMITTALS

- A. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
- B. Material Certificates: For each acoustic wall coating component, from manufacturer.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For acoustic wall coating to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Engage an installer who is certified in writing by acoustic wall coating manufacturer as qualified to apply acoustic wall coating systems indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Comply with acoustic wall coating manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting acoustic wall coating application.

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PA-745-210-001

- B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during acoustic wall coating application.
- C. Close spaces to traffic during acoustic wall coating application and for 24 hours after application unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Verify products comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. System Physical Properties: Provide acoustic wall coating system meeting the following minimum physical property requirements:
 - 1. VOC Content: 4 g/l per ASTM D-2369, Method E.
 - 2. Flammability: Class 1 per ASTM E-648.
 - 3. Compressive Strength: 300 psi minimum according to ASTM E761.
 - 4. Bond Strength: 5000 lbs/ sf minimum according to ASTM E736.
 - 5. Sound Absorption: 0.60 NRC at 1" thick, according to ASTM C423.
 - 6. Density: 41 lbs/ cf per ASTM E605.
 - 7. Hardness: 70, Shore D according to ASTM D2240.

2.2 ACOUSTIC WALL COATING (AWC-1)

- A. Acoustic Wall Coating: Abrasion-, impact-, and chemical-resistant, portland cement-vermiculite material, designed to produce a seamless wall coating.
 - 1. Basis of Design: Refer to Interior Finish Schedule on Drawing ID001.
- B. Coating:
 - 1. Material: Portland cement-vermiculite material.
 - 2. Type: Pigmented.
 - 3. Application Method: Spray.
 - 4. Thickness: 1 inch.
 - 5. Texture: As selected by Architect.
 - 6. Basis of Design: Pyrok Acoustement 40 acoustic material.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare and clean substrates according to acoustic wall coating manufacturer's written instructions for substrate indicated. Provide clean, dry substrate for acoustic wall coating application.
- B. Substrates: Provide sound surfaces free of laitance, glaze, efflorescence, dust, dirt, grease, oil, and other contaminants incompatible with acoustic wall coating.
- C. Coating Material: Mix components and prepare materials according to acoustic wall coating manufacturer's written instructions.

3.2 INSTALLATION

- A. Apply components of acoustic wall coating system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
 - 1. Coordinate application of components to provide optimum adhesion of acoustic wall coating system to substrate, and optimum adhesion.
 - 2. Cure acoustic wall coating components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
- B. Coating: Apply coating at spreading rates recommended by manufacturer to produce wearing surface indicated.

3.3 PROTECTION

- A. Protect acoustic wall coating from damage and wear during the remainder of construction period.
- B. Use protective methods and materials, including temporary covering, recommended in writing by acoustic wall coating manufacturer.

END OF SECTION 098313

SECTION 098433 - SOUND-DIFFUSING WALL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes shop-fabricated, acoustical panel units tested for acoustical performance, including the following:
 - 1. Sound-diffusing wall panels.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include panel edge, core material, and mounting indicated.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
 - 3. Chain-of-Custody Qualification Data: For manufacturer and vendor.
 - 4. Product Data: For adhesives, indicating VOC content.
 - 5. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 6. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
 - 7. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For unit assembly and installation.
 - 1. Include plans, elevations, sections, and mounting devices and details.
 - 2. Include details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate panel edge profile and core materials.
 - 3. Include details at cutouts and penetrations for other work.
 - 4. Include direction of fabric weave and pattern matching.
- D. Samples for Verification: For the following products:
 - 1. Core Material: 12-inch- square Sample at corner.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of unit.
- B. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of unit to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal instructions.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Mounting Devices: Full-size units equal to no fewer than five devices, including unopened adhesives.

1.7 QUALITY ASSURANCE

- A. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with fabric and unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.
- B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Lighting: Do not install units until a lighting level of not less than 50 fc is provided on surfaces to receive the units.
- C. Air-Quality Limitations: Protect units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.
- D. Field Measurements: Verify unit locations and actual dimensions of openings and penetrations by field measurements before fabrication, and indicate them on Shop Drawings.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace units and components that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to the following:
 - a. Acoustical performance.
 - b. Fabric sagging, distorting, or releasing from panel edge.
 - c. Warping of core.
 - 2. Warranty Period: Two years from date of Substantial Completion.

2.1 MANUFACTURERS

- A. Source Limitations: Obtain wall units specified in this Section from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Verify wall materials comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Fire-Test-Response Characteristics: Units shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. Surface-Burning Characteristics: Comply with ASTM E1264; Class A; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 Method B Protocol or NFPA 286.

2.3 SOUND-DIFFUSING WALL UNITS

- A. Sound-Diffusing Wall Panel (AP-1 thru AP-3): Manufacturer's standard panel construction consisting of wood fibers bonded to cement.
- B. Basis-of-Design Product: Refer to Interior Finish Schedule on Drawing ID001.
- C. Acoustic Panel:
 - 1. Panel Shape and Size: As indicated on Drawings.
 - 2. Mounting: Direct attached with adhesive recommended by manufacturer's, secured to substrate.
 - 3. Composition: 100% polyester.
 - 4. Finish: Surface appearance shall be consistent from panel to panel
 - 5. Color: Refer to Interior Finish Schedule on Drawing ID001.
 - 6. Acoustical Performance: Sound absorption NRC of 0.45 according to ASTM C423.
 - 7. Panel Thickness: 12 mm.

2.4 MATERIALS

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.
- B. Regional Materials: Manufacture products within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.

2.5 FABRICATION

- A. Standard Construction: Use manufacturer's standard construction unless otherwise indicated; with dimensionally stable core.
- B. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch for the following:
 - 1. Thickness.
 - 2. Edge straightness.
 - 3. Overall length and width.
 - 4. Squareness from corner to corner.
 - 5. Chords, radii, and diameters.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fabric, fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install units in locations indicated. Unless otherwise indicated, install units with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
- B. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.

3.3 INSTALLATION TOLERANCES

- A. Variation from Plumb and Level: Plus or minus 1/16 inch in 48 inches, noncumulative.
- B. Variation of Joint Width: Not more than 1/16-inch variation from hairline in 48 inches, noncumulative.

3.4 CLEANING

- A. Clip loose threads; remove pills and extraneous materials.
- B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION 098433

SECTION 099000 - PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on interior and exterior substrates.

1.2 DEFINITIONS

- A. Gloss Levels are defined as follows:
- 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523, a matte flat finish.
 - 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523, a high-side sheen flat, velvet-like finish.
 - 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523, an eggshell finish.
 - 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523, a satin-like finish.
 - 5: 35 to 70 units at 60 degrees, according to ASTM D 523, a semi-gloss finish.
 - 6: 70 to 85 units at 60 degrees, according to ASTM D 523, a gloss finish.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Sustainable Submittals:
- C. Sustainable Design Submittals:
1. **Product Data:** For paints and coatings, indicating VOC content.
 2. **Laboratory Test Reports:** For paints and coatings, indicating compliance with requirements for low-emitting materials.
 3. **Environmental Product Declaration:** For each product.
 4. **Health Product Declaration:** For each product.
 5. **Sourcing of Raw Materials:** Corporate sustainability report for each manufacturer.
 6. **Manufacturer Inventory:** For each product, provide manufacturer's manifest of ingredients.
 7. **Low-Emitting Materials:** Interior paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
1. Submit Samples on rigid backing, 8 inches square.
 2. Step coats minimum 1 inch on samples to show each coat required for system.
 3. Label each coat of each sample.
 4. Label each Sample for location and application area.
- E. Product List: For each product indicated, include the following:
1. Schedule: List each material proposed for use, and cross-reference to specific coating system and substrate application.
 2. VOC content.

1.4 CLOSEOUT SUBMITTALS

- A. Coating Maintenance Manual: Provide coating maintenance manual including area summary with finish schedule, area detail designating location where each product/color/finish was used, product data pages, material safety data sheets, care and cleaning instructions, touch-up procedures, and color samples of each color and finish used.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Handling: Deliver products to Project site in an undamaged condition in manufacturer's original sealed containers, complete with labels and instructions for handling, storing, unpacking, protecting, and installing. Packaging shall bear the manufacturer's label with the following information:
 - 1. Product name and type (description).
 - 2. Batch date.
 - 3. Color number.
 - 4. VOC content.
 - 5. Environmental handling requirements.
 - 6. Surface preparation requirements.
 - 7. Application instructions.
- B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply interior paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- C. Do not apply exterior paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- D. Provide lighting level of 80 ft candle measured mid-height at substrate surface.

1.7 EXTRA MATERIAL

- A. Furnish extra materials from the same product run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Paint:
 - 1. Supply 1 gallon container of each color with minimum 3/4 gallon; store where directed.
 - 2. Label each container with color, type, texture, and room locations, in addition to manufacturer's label.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products from one of the following:
 - 1. Basis of Design: Sherwin-Williams Inc. products are listed as a standard of quality, unless noted otherwise.
 - 2. PPG Architectural Finishes.
 - 3. Pratt and Lambert, Inc.

4. McCormick Paints.
5. Benjamin Moore.
6. Duron Paints.
7. Behr Paints.

- B. Source Limitations: Obtain paint materials from single source from single listed manufacturer.
1. Manufacturer's designations listed on a separate color schedule are for color reference only and do not indicate prior approval.

2.2 PAINT, GENERAL

- A. Material Compatibility:
1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. **VOC Content:** For field applications that are inside the weatherproofing system, verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
1. Flat Paints and Coatings: 50 g/L.
 2. Nonflat Paints and Coatings: 50 g/L.
 3. Dry-Fog Coatings: 150 g/L.
 4. Primers, Sealers, and Undercoaters: 100 g/L.
 5. Rust-Preventive Coatings: 100 g/L.
 6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
 7. Pretreatment Wash Primers: 420 g/L.
 8. Shellacs, Clear: 730 g/L.
 9. Shellacs, Pigmented: 550 g/L.
- C. Colors:
1. Exterior: Colors to be selected By Architect.
 2. Interior: Refer to Finish Schedule on Drawing ID100.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers. Where acceptability of substrate conditions is in question, apply samples and perform in-situ testing to verify compatibility, adhesion, and film integrity of new paint application.
1. Report, in writing, conditions that may affect application, appearance, or performance of paint.
- B. Substrate Conditions:
1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - a. Wood: 15 percent.
 - b. Gypsum Board: 12 percent.
 2. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected; application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations.
- B. Remove hardware, covers, plates, labels and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.
 - 1. SSPC-SP 2, "Hand Tool Cleaning."
 - 2. SSPC-SP 3, "Power Tool Cleaning."
 - 3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
 - 4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- G. Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance. Number of coats specified are minimum number acceptable.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Apply coating systems to total dry film thickness scheduled. Apply material at not less than manufacturer's recommended spreading rate. Do not exceed maximum single coat thickness recommended by coating manufacturer. Do not double-back with spray equipment building up film thickness of two coats in one pass.
- F. Finish edges of coatings adjoining other materials or colors sharp and clean, without overlapping.
- G. Spot painting will be allowed to correct soiled or damaged paint surfaces only when touch-up spot will blend into surrounding finish and is invisible to normal viewing. Otherwise, re-coat entire section to corners or visible stopping point.
- H. Finish Matching:
 - 1. Finish closets same as adjoining rooms, unless otherwise specified.
 - 2. Finish tops, bottoms, and edges of doors same as door faces. Apply sanding sealer to cut-outs. When faces are different colors, finish edges of doors to match space from which they are visible when door is in partly open position.
 - 3. Finish other surfaces not specifically mentioned to match adjoining surfaces.
- I. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed in occupied spaces:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - h. Sprinkler pipe and risers.
 - 2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

- A. Ferrous Metal, Galvanized-Metal, and Aluminum Substrates:
 - 1. Water-Based Light Industrial Coating System:
 - a. Prime Coat: Primer, water-based, anti-corrosive for metal, S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series, 5.0 to 10.0 mils wet, 2.0 to 4.0 mils dry.
 - b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
 - c. Topcoat: Light industrial coating, exterior, water based, eggshell, (Gloss Level 3) : S-W Pro Industrial Eg-Shel Acrylic B66-660 Series, at 2.5 to 4.0 mils dry, per coat.

3.7 INTERIOR PAINTING SCHEDULE

- A. Metal Substrates (Aluminum, Steel, Galvanized Steel):
 - 1. Latex System:
 - a. Prime Coat: Primer, rust-inhibitive, water based: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series, at 5.0 to 10 mils wet, 2.0 to 4.0 mils dry.
 - b. Intermediate Coat: Water-based acrylic, interior, matching topcoat.
 - c. Topcoat: Water-based acrylic, semi-gloss, (Gloss Level 5): S-W Pro Industrial Acrylic Semi-Gloss Coating, B66-650 Series, at 2.5 to 4.0 mils dry, per coat.
- B. Wood Substrates: Including exposed wood items not indicated to receive shop-applied finish.
 - 1. Stained Interior wood.
 - a. 1st Coat: S-W Wood Classics Interior Oil Stain, A49 Series
 - b. 2nd Coat: S-W Wood Classics Waterborne Polyurethane Varnish, Gloss A68 Series
 - c. 3rd Coat: S-W Wood Classics Waterborne Polyurethane Varnish, Gloss or Satin (4 mils wet, 1.0 mil dry per coat)
- C. Gypsum Board Substrates:
 - 1. Latex System - Walls:
 - a. Prime Coat: Primer, latex, interior: S-W ProMar 200 Zero VOC Latex Primer, B28W2600, at 4.0 mils wet, 1.5 mils dry.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, eggshell, (Gloss Level 3): S-W ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series, at 4.0 mils wet, 1.7 mils dry, per coat.
 - 2. Latex System - Ceilings:
 - a. Prime Coat: Primer, latex, interior: S-W ProMar 200 Zero VOC Latex Primer, B28W2600, at 4.0 mils wet, 1.5 mils dry.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, flat, (Gloss Level 1): S-W ProMar 200 Zero VOC Latex Flat, B30-2600 Series, at 4.0 mils wet, 1.6 mils dry, per coat.

END OF SECTION 099000

SECTION 099611 - HIGH-PERFORMANCE COATINGS (PROPRIETARY SPECIFICATION)

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and application of high-performance coating systems on the following substrates:
1. Interior Substrates:
 - a. CMUs.
 - b. Gypsum board.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
1. Indicate VOC content.
- B. Sustainable Design Submittals:
1. [Product Data](#): For paints and coatings, indicating VOC content.
 2. Laboratory Test Reports: For paints and coatings, indicating compliance with requirements for low-emitting materials.
 3. [<Double click to insert sustainable design text for regional materials.>](#)
- C. Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated.
1. Submit Samples on actual substrate material to be coated, 8 inches square.
 2. Apply coats on Samples in steps to show each coat required for system.
 3. Label each coat of each Sample.
 4. Label each Sample for location and application area.
- D. Product List: Use same designations indicated on Drawings and in Exterior High-Performance Coating Schedule and Interior High-Performance Coating Schedule. Include color designations and product runs (batch numbers).

1.3 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Coatings: 2 gal. of each material and color applied.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide StonGlaze VSR by Stonhard or comparable product by one of the following:
 - 1. Carboline Company; a subsidiary of RPM International.
 - 2. Rust-Oleum Corporation; a subsidiary of RPM International, Inc.
 - 3. Sherwin-Williams Company (The).
 - 4. Tnemec Company, Inc.

2.2 HIGH-PERFORMANCE COATINGS

- A. Material Compatibility:
 - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
 - 3. Products shall be of same manufacturer for each coat in a coating system.
- B. VOC Content: For field applications, verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
 - 1. Flat Paints and Coatings: 50 g/L.
 - 2. Nonflat Paints and Coatings: 50 g/L.
 - 3. Primers, Sealers, and Undercoaters: 100 g/L.
- C. Low-Emitting Materials: For field applications that are inside the weatherproofing system, verify 90 percent of paints and coatings comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- D. Colors: As indicated in Interior Finish Schedule on Drawing ID001.

2.3 BLOCK FILLERS

- A. Epoxy Block Filler: Solvent-based, two-component, epoxy, high-solids coating; formulated to bridge and fill porous surfaces of CMUs in preparation for specified intermediate and topcoat coatings.

2.4 INTERIOR PRIMERS/SEALERS

- A. Interior Latex Primer Sealer: Pigmented, water-based latex sealer; formulated to reduce porosity of substrate for finish coats; for use on new interior plaster, concrete, and gypsum board surfaces. Not intended for use on wood or previously painted surfaces.

2.5 EPOXY COATINGS

- A. Epoxy, Gloss: Solvent-based, two-component, epoxy coating; formulated resistance to incidental splash and spillage of dilute (5 percent) sulfuric acid, (15 percent) hydrochloric acid, (20 percent) sodium hydroxide, gasoline, and heavy-duty cleaners and detergents; for use on wall and floor surfaces in moderate to heavy traffic commercial and moderate industrial environments.
 - 1. Gloss Level: Manufacturer's standard gloss finish.

2.6 SOURCE QUALITY CONTROL

- A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:
 - 1. Owner will engage services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, both coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. CMUs: 12 percent.
 - 2. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted.
 - 1. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 2. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed.
 - 3. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.
- D. Masonry Substrates: Remove efflorescence and chalk.
 - 1. Do not coat surfaces if moisture content, alkalinity of surfaces, or alkalinity of mortar joints exceeds that permitted in manufacturer's written instructions.
 - 2. Clean surfaces with pressurized water. Use pressure range of 100 to 600 psi at 6 to 12 inches.

3.3 APPLICATION

- A. Apply high-performance coatings in accordance with manufacturer's written instructions.
 - 1. Use applicators and techniques suited for coating and substrate indicated.
 - 2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Coat backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
- D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.
 - 1. Contractor shall touch up and restore coated surfaces damaged by testing.

2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written instructions, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written instructions.

3.5 CLEANING AND PROTECTION

- A. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- B. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.
- C. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

- A. CMU Substrates:
 1. Epoxy System for Dry Environments:
 - a. Block Filler: Block filler, latex, interior/exterior.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss.
 2. Epoxy System for Wet Environments:
 - a. Block Filler: Block filler, epoxy.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss.
- B. Gypsum Board Substrates:
 1. Epoxy System:
 - a. Prime Coat: Primer sealer, latex, interior.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss.

END OF SECTION 099611

SECTION 101100 - VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Visual display board assemblies.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Visual display board assemblies.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.

C. Sustainable Design Submittals:

1. **Product Data:** For installation adhesives, indicating VOC content.
2. **Laboratory Test Reports:** For installation adhesives, indicating compliance with requirements for low-emitting materials.
3. **Laboratory Test Reports:** For composite wood products, indicating compliance with requirements for low-emitting materials.

D. Shop Drawings: For visual display units.

1. Include plans, elevations, sections, details, and attachment to other work.
2. Show locations of panel joints. Show locations of field-assembled joints for factory-fabricated units too large to ship in one piece.
3. Show locations and layout of special-purpose graphics.
4. Include sections of typical trim members.

E. Samples for Initial Selection: For each type of visual display unit indicated, for units with factory-applied color finishes, and as follows:

1. Samples of facings for each visual display panel type, indicating color and texture.
2. Fabric swatches of fabric facings for tackboards.
3. Actual factory-finish color samples, applied to aluminum substrate.
4. Include accessory Samples to verify color selected.

F. Samples for Verification: For each type of visual display unit indicated.

1. Visual Display Panel: Not less than 8-1/2 by 11 inches (215 by 280 mm), with facing, core, and backing indicated for final Work. Include one panel for each type, color, and texture required.
2. Trim: 6-inch- (150-mm-) long sections of each trim profile.
3. Accessories: Full-size Sample of each type of accessory.

G. Product Schedule: For visual display units. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each visual display unit, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Sample Warranties: For manufacturer's special warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For visual display units to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-fabricated visual display units completely assembled in one piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one piece, provide two or more pieces with joints in locations indicated on approved Shop Drawings.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.8 WARRANTY

- A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Surfaces lose original writing and erasing qualities.
 - b. Surfaces exhibit crazing, cracking, or flaking.
2. Warranty Period:
 - a. 50 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 50 or less.

2.2 VISUAL DISPLAY BOARD ASSEMBLIES

- A. Visual Display Board Assemblies: MB-1, TB-1
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ADP Lemco.
 - b. ASI Visual Display Products.
 - c. Claridge Products and Equipment, Inc.
 2. Assembly: Markerboard and tackboard.
 3. Corners: Square.
 4. Width: As indicated on Drawings.
 5. Height: 48".
 6. Mounting Method: Direct to wall.
- B. Markerboard Panel: Porcelain-enamel-faced markerboard panel on core indicated.
 1. Color: White.
- C. Tackboard Panel: Plastic-impregnated-cork tackboard panel on core indicated.
 1. Color and Pattern: As selected by Architect from full range of industry colors.
- D. Aluminum Frames and Trim: Fabricated from not less than **0.062-inch-** (1.57-mm-) thick, extruded aluminum; standard size and shape.
 1. Aluminum Finish: Clear anodic finish.

- E. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect.
- F. Combination Assemblies: Provide manufacturer's standard exposed trim between abutting sections of visual display panels.
- G. Chalktray: Manufacturer's standard; continuous.
 - 1. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.

2.3 MARKERBOARD PANELS

- A. Porcelain-Enamel Markerboard Panels: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction, consisting of moisture-barrier backing, core material, and porcelain-enamel face sheet with high-gloss finish. Laminate panels under heat and pressure with manufacturer's standard, flexible waterproof adhesive.
 - 1. Manufacturer's Standard Core: Minimum **1/4 inch (6 mm)** thick, with manufacturer's standard moisture-barrier backing.
 - 2. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.

2.4 TACKBOARD PANELS

- A. Tackboard Panels:
 - 1. Facing:
 - a. **1/4-inch- (6-mm-)** thick, plastic-impregnated cork.
 - 2. Core:
 - a. Manufacturer's standard.

2.5 MATERIALS

- A. Porcelain-Enamel Face Sheet: PEI-1002, with face sheet manufacturer's standard two- or three-coat process.
- B. Plastic-Impregnated-Cork Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto fabric backing; with washable vinyl finish and integral color throughout; with surface-burning characteristics indicated.
- C. **Composite Wood Products**: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.
- D. Hardboard: ANSI A135.4, tempered.

- E. Particleboard: ANSI A208.1, Grade M-1.
- F. MDF: ANSI A208.2, Grade 130.
- G. Fiberboard: ASTM C208 cellulosic fiber insulating board.
- H. Clear Tempered Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering.
- I. Extruded Aluminum: **ASTM B221 (ASTM B221M)**, Alloy 6063.
- J. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by visual display unit manufacturer.
 - 1. Verify adhesives have a VOC content of 50 g/L or less.
 - 2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- K. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Section 099123 "Interior Painting" and recommended in writing by visual display unit manufacturer for intended substrate.

2.6 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical power systems to verify actual locations of connections before installation of motorized, sliding visual display units.
- C. Examine walls and partitions for proper preparation and backing for visual display units.
- D. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.
- C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display units and wall surfaces.
- D. Prime wall surfaces indicated to receive visual display units and as recommended in writing by primer/sealer manufacturer and visual display unit manufacturer.

3.3 INSTALLATION

- A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- B. Field-Assembled Visual Display Board Assemblies: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.
 - 1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect.
 - 2. Where size of visual display board assemblies or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as

selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.

- C. Factory-Fabricated Visual Display Board Assemblies:
 - 1. Attach concealed clips, hangers, and grounds to wall surfaces and to visual display board assemblies with fasteners at not more than **16 inches (400 mm)** o.c. Secure tops and bottoms of boards to walls.
- D. Visual Display Board Assembly Mounting Heights: Install visual display units at mounting heights indicated on Drawings, or if not indicated, at heights indicated below.
 - 1. Mounting Height: **36 inches (914 mm)** above finished floor to top of chalktray.

3.4 CLEANING AND PROTECTION

- A. Clean visual display units in accordance with manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display units after installation and cleaning.

END OF SECTION 101100

SECTION 101416 - PLAQUES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal plaques.

B. Related Requirements:

1. Section 101423 "Panel Signage" and Section 101423.16 "Room-Identification Panel Signage" for plaques or signs similar to metal plaques, with or without frames, except that they are made of materials other than solid metal.
2. Section 142400 "Hydraulic Elevators" for code-required conveying equipment signage.

1.2 ALLOWANCES

- A. Allowances for plaques are specified in Section 012100 "Allowances."

1.3 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For plaques.

1. Include fabrication and installation details and attachments to other work.
2. Show plaque mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, and layout for each plaque at least half size.

- D. Samples for Initial Selection: For each type of plaque, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For plaques to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 METAL PLAQUES

- A. Cast Plaque: Cast-metal plaque with background texture, border, and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Plaque Material: Cast bronze.
 3. Plaque Thickness: **0.25 inch (6.35 mm)**.
 4. Finishes:
 - a. Integral Metal Finish: Mill finish raised surface with dark oxidized background.
 - b. Overcoat: Manufacturer's standard baked-on clear coating.
 5. Background Texture: Smooth.
 6. Integrally Cast Border Style: Square single line, polished.
 7. Mounting: Concealed studs.
 8. Text and Typeface: Typeface as selected by Architect from manufacturer's full range. Finish raised characters to contrast with background color.

2.2 MATERIALS

- A. Bronze Castings: ASTM B584, alloy recommended by manufacturer and finisher for finish indicated.

2.3 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of plaques, noncorrosive and compatible with each material joined, and complying with the following:
 1. Use concealed fasteners and anchors unless indicated to be exposed.
 2. Plaque Mounting Fasteners:
 - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of plaque, screwed into back of plaque, or screwed into tapped lugs cast integrally into back of plaque unless otherwise indicated.

2.4 FABRICATION

- A. General: Provide manufacturer's standard plaques according to requirements indicated.
 - 1. Preassemble plaques in the shop to greatest extent possible. Disassemble plaques only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 - 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 5. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match plaque finish.
 - 6. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

2.5 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.6 LACQUER COATING FOR COPPER-ALLOY FINISHES

- A. Lacquer Coating: Clear, organic, waterborne, air-drying, acrylic lacquer called "Incralac"; specially developed for coating copper-alloy products; consisting of a solution of acrylic resin, methyl methacrylate copolymer, leveling agent, and corrosion inhibitor benzotriazole.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

- B. Verify that plaque-support surfaces are within tolerances to accommodate plaques without gaps or irregularities between backs of plaques and support surfaces unless otherwise indicated.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL PLAQUES

- A. General: Install plaques using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install plaques level, plumb, true to line, and at locations and heights indicated, with plaque surfaces free of distortion and other defects in appearance.
 - 2. Install plaques so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that plaque surfaces are clean and free of materials or debris that would impair installation.
 - 4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Mounting Methods:
 - 1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of plaque. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place plaque in position and push until flush to surface, embedding studs in holes. Temporarily support plaque in position until adhesive fully sets.
 - b. Thin or Hollow Surfaces: Place plaque in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed plaques and plaques that do not comply with specified requirements. Replace plaques with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as plaques are installed.
- C. On completion of installation, clean exposed surfaces of plaques according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain plaques in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101416

SECTION 101419 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Dimensional characters.
 - a. Cast dimensional characters.

1.2 ALLOWANCES

- A. Allowances for dimensional letter signs are specified in Section 012100 "Allowances."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, and layout for each sign at least half size.
- D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
 - 1. Dimensional Characters: Half-size Sample of dimensional character.
- E. Product Schedule: For dimensional letter signs. Use same designations indicated on Drawings or specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify locations of electrical service embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Separation or delamination of sheet materials and components.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DIMENSIONAL CHARACTERS

- A. Cast Characters: Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:
 - 1. Character Material: Cast aluminum.
 - 2. Character Height: As indicated on Drawings.
 - 3. Thickness: Manufacturer's standard for size of character.
 - 4. Finishes:
 - a. Integral Aluminum Finish: Clear anodized.
 - 5. Mounting: Concealed studs.

2.2 DIMENSIONAL CHARACTER MATERIALS

- A. Aluminum Castings: ASTM B26/B26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.
- B. Aluminum Sheet and Plate: **ASTM B209** (ASTM B209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

2.3 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
1. Use concealed fasteners and anchors unless indicated to be exposed.
 2. For exterior exposure, furnish stainless steel devices unless otherwise indicated.
 3. Exposed Metal-Fastener Components, General:
 - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
 4. Sign Mounting Fasteners:
 - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
 - b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
 - c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, installed in predrilled holes.

2.4 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
 6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
 7. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

2.5 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.6 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DIMENSIONAL CHARACTERS

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 - 3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
 - b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101419

SECTION 101423.16 - ROOM-IDENTIFICATION PANEL SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes room-identification signs that are directly attached to the building.
- B. Related Requirements:
 - 1. Section 101416 "Plaques" for one-piece, solid metal signs, with or without frames, that are used for high-end room-identification.

1.2 ALLOWANCES

- A. Allowances for signage are specified in Section 012100 "Allowances."

1.3 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

1.4 COORDINATION

- A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.
- B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. **Product Data:** For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For room-identification signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
- D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
 - 1. Room-Identification Signs: Full-size Sample.
 - 2. Full-size Samples, if approved, will be returned to Contractor for use in Project.
- E. Product Schedule: For room-identification signs. Use same designations indicated on Drawings or specified.

1.6 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image.
 - c. Separation or delamination of sheet materials and components.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design".

2.2 ROOM-IDENTIFICATION SIGNS

- A. Room-Identification Sign: Sign system with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
 - 1. Laminated-Sheet Sign: Acrylic face sheet with raised graphics laminated to acrylic backing sheet to produce composite sheet.
 - a. Composite-Sheet Thickness: 0.375 inch.
 - b. Graphics: Applied direct print to second surface.
 - c. Color(s): As selected by Architect from manufacturer's full range.
 - 2. Sign-Panel Perimeter: Finish edges smooth.
 - 3. Mounting: Manufacturer's standard method for substrates indicated with adhesive.
 - 4. Text and Typeface: Accessible raised characters and Braille typeface as selected by Architect from manufacturer's full range and variable content as scheduled. Finish raised characters to contrast with background color, and finish Braille to match background color.
- B. Basis-of-Design: Takeform VIVID Sign System.

2.3 SIGN MATERIALS

- A. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

2.4 ACCESSORIES

- A. Adhesive: As recommended by sign manufacturer.
 - 1. Verify adhesives have a VOC content of 70 g/L or less.
 - 2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 4. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
- B. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.

2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

- B. Accessibility: Install signs in locations on walls according to the accessibility standard.
- C. Mounting Methods:
 - 1. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.

3.2 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101423.16

SECTION 102113.19 - PLASTIC TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-plastic toilet compartments.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for blocking.
2. Section 102800 "Toilet, Bath, and Laundry Accessories" for accessories mounted on toilet compartments.

1.2 COORDINATION

- A. Coordinate requirements for blocking, reinforcing, and other supports concealed within wall to ensure that toilet compartments can be supported and installed as indicated.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Solid-plastic toilet compartments: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment details.
2. Show locations of cutouts for compartment-mounted toilet accessories.
3. Show locations of centerlines of toilet fixtures.
4. Show locations of floor drains.

C. Samples for Verification: Actual sample of finished products for each type of toilet compartment, hardware, and accessory.

1. Size: Manufacturer's standard size.

D. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing location and selected colors for toilet compartment material.

E. Sustainable Design Submittals:

1. [Product Data](#): For recycled content, indicating postconsumer and preconsumer recycled content and cost.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For toilet compartments.

1.5 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements, and coordinate before fabrication.

2.1 SOURCE LIMITATIONS

- A. Obtain plastic toilet compartments from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. **Recycled Content:** Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.
- B. **Regional Materials:** Manufacture products within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.
- C. Fire Performance: Tested in accordance with, and pass the acceptance criteria of, NFPA 286.
- D. Structural Performance: Where grab bars are mounted on toilet compartments, design panels to comply with the following requirements:
 - 1. Panels are able to withstand a concentrated load on grab bar of at least 250 lbf applied at any direction and at any point, without deformation of panel.
- E. Regulatory Requirements: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1 for toilet compartments designated as accessible.

2.3 SOLID-PLASTIC TOILET COMPARTMENTS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide **Scranton Products;** Eclipse Partitions or a comparable product by one of the following:
 - 1. **ASI Accurate Partitions.**
 - 2. **General Partitions Mfg. Corp.**
 - 3. **Knickerbocker Partition Corporation.**
- B. Toilet-Enclosure Style: Floor anchored over-head braced.
- C. Urinal-Screen Style: Wall hung.
- D. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) material, not less than 1 inch thick, seamless, with eased edges, and with homogenous color throughout thickness of material.
 - 1. Integral Hinges: Configure doors and pilasters to receive integral hinges.
 - 2. Heat-Sink Strip: Manufacturer's continuous, extruded-aluminum or stainless steel strip fastened to exposed bottom edges of solid-plastic components to hinder malicious combustion.
 - 3. Color: as selected by Architect from manufacturer's full range.
- E. Urinal-Screen Construction: Matching panel construction.
- F. Metal Posts: Heavy duty extruded aluminum post, clear anodized, fastened to foot with tamper-proof stainless steel screws.

- G. Pilaster Shoes: Manufacturer's standard design; stainless steel.
- H. Pilaster Sleeves (Caps): Manufacturer's standard design; stainless steel.
- I. Brackets (Fittings):
 - 1. Stirrup Type: Ear or U-brackets, aluminum.
 - 2. Full-Height (Continuous) Type: Manufacturer's standard design; extruded aluminum.

2.4 HARDWARE AND ACCESSORIES

- A. Door Hardware and Accessories: Manufacturer's operating hardware and accessories.
 - 1. Hinges:
 - a. Manufacturer's hidden pivots, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees, allowing emergency access by lifting door.
 - 1) Material: Cast Aluminum.
 - 2. Latch and Keeper: Manufacturer's surface-mounted latch unit, designed for emergency access, and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at toilet enclosures designated as accessible.
 - a. Material: Aluminum.
 - 3. Coat Hook: Manufacturer's combination hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories.
 - a. Material: Chrome-plated zamac.
 - 4. Door Bumper: Manufacturer's rubber-tipped bumper at outswinging doors.
 - a. Material: Chrome-plated zamac.
 - 5. Door Pull: Manufacturer's unit at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at toilet enclosures designated as accessible.
 - a. Material: Stainless steel.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.5 MATERIALS

- A. Aluminum Castings: ASTM B26/B26M.
- B. Aluminum Extrusions: ASTM B221.
- C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.
- D. Stainless Steel Castings: ASTM A743/A743M.
- E. Zamac: ASTM B86, commercial zinc-alloy die castings.

2.6 FABRICATION

- A. Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.
- B. Overhead-Braced Units: Manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters and walls to suit floor and wall conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
- C. Floor-Anchored Units: Manufacturer's standard corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.
- D. Door Size and Swings: Unless otherwise indicated, provide 24-inch- wide, inswinging doors for standard toilet enclosures and 36-inch- wide, outswinging doors with a minimum 32-inch- wide, clear opening for toilet enclosures designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
 - 1. Confirm location and adequacy of blocking and supports required for installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
 - 1. Maximum Clearances:
 - a. Pilasters and Panels or Screens: 1/2 inch.
 - b. Panels or Screens and Walls: 1 inch.
 - 2. Full-Height (Continuous) Brackets: Secure panels or screens to walls and to pilasters with full-height brackets.
 - a. Locate bracket fasteners, so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.
- B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels and adjust, so tops of doors are parallel with overhead brace when doors are in closed position.
- C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

Maryland State Police
Tactical Administration Center
PA-745-210-001
3.3 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware in accordance with hardware manufacturer's written instructions for proper operation. Set hinges on inswinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on outswinging doors to return doors to fully closed position.

END OF SECTION 102113.19

SECTION 102600 - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Corner guards.
 2. Rub strip.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.
- B. Sustainable Design Submittals:
1. Chain-of-Custody Qualification Data: For manufacturer and vendor.
 2. Product Data: For adhesives, indicating VOC content.
 3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For each type of wall and door protection showing locations and extent.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of wall and door protection product to include in maintenance manuals.
1. Include recommended methods and frequency of maintenance for maintaining best condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.
 2. Keep plastic materials out of direct sunlight.
 3. Store plastic wall- and door-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F.

1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of wall-protection units that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.

- b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain wall- and door-protection products of each type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 450 or less.
- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1.

2.3 CORNER GUARDS

- A. Surface-Mounted, Plastic-Cover Corner Guards (CG-2): Manufacturer's standard assembly consisting of snap-on, resilient plastic cover installed over retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition.
 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide products from one of the following:
 - a. [Construction Specialties, Inc.](#)
 - b. [Koroseal Interior Products, LLC.](#)
 - c. [Pawling Corporation.](#)
 - d. [inpro Corporation.](#)
 2. Cover: Extruded rigid plastic, minimum 0.078-inch wall thickness; as follows:
 - a. Profile: Nominal 3-inch- long leg and 1/4-inch corner radius.
 - b. Height: Refer to Interior Finish Schedule on Drawing ID001.
 - c. Color and Texture: Refer to Interior Finish Schedule on Drawing ID001.
 3. Continuous Retainer: Minimum 0.060-inch- thick, one-piece, extruded aluminum.
 4. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
- B. Surface-Mounted, Metal Corner Guards (CG-1): Fabricated as one piece from formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.
 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Babcock-Davis.](#)
 - b. [Balco, Inc.](#)
 - c. [Construction Specialties, Inc.](#)
 - d. [Pawling Corporation.](#)
 2. Material: Stainless-steel sheet, Type 304.
 - a. Thickness: Minimum 0.0625 inch.

- b. Finish: Directional satin, No. 4.
3. Wing Size: Nominal 3-1/2 by 3-1/2 inches.
4. Corner Radius: 1/8 inch.
5. Mounting: Mechanically fastened with stainless steel countersunk screws.

2.4 WALL GUARDS

- A. Rub Strip CR-1: Continuous strip, consisting of minimum 0.060-inch- thick, semirigid, plastic sheet wall-covering material.
 1. Height: 8 inches nominal, unless noted otherwise.
 2. Color and Texture: Refer to Interior Finish Schedule on Drawing ID001.
 3. Mounting: Surface mounted with adhesive.
 4. Basis of Design: Refer to Interior Finish Schedule on Drawing ID001.

2.5 MATERIALS

- A. Plastic Materials: Chemical- and stain-resistant, high-impact-resistant plastic with integral color throughout; extruded and sheet material as required, thickness as indicated.
- B. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.
- C. Adhesive: As recommended by protection product manufacturer.
 1. Verify adhesives have a VOC content of 70 g/L or less.
 2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.6 FABRICATION

- A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.
- B. Quality: Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

2.7 FINISHES

- A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

3.1 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
 - 1. For wall and door protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing wall and door protection.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. Installation Quality: Install wall and door protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
- B. Mounting Heights: Install wall and door protection in locations and at mounting heights indicated on Drawings.
- C. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.
 - 1. Provide anchoring devices and suitable locations to withstand imposed loads.
 - 2. Adjust end caps as required to ensure tight seams.

3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.
- B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 102600

SECTION 102800 – TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Public-use washroom accessories.
 - 2. Private-use bathroom accessories.
 - 3. Custodial accessories.
- B. Related Requirements:
 - 1. Section 088300 "Mirrors" for frameless mirrors.

1.2 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
- B. Samples: Full size, for each exposed product and for each finish specified.
 - 1. Approved full-size Samples will be returned and may be used in the Work.
- C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated.
 - 2. Identify accessories using designations indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

1.6 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, visible silver spoilage defects.
 - 2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED MATERIALS

- A. Owner-Furnished Materials:
 - 1. Paper towel dispensers.
 - 2. Waste receptacles.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Source Limitations: Obtain public-use washroom accessories from single source from single manufacturer.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AJW Architectural Products.
 - 2. American Specialties, Inc.
 - 3. Bobrick Washroom Equipment, Inc.
 - 4. Bradley Corporation.
 - 5. GAMCO Specialty Accessories; a division of Bobrick
- C. TA-1 Grab Bar:
 - 1. Basis of Design: Bobrick Model B-6806 x length indicated.
 - 2. Mounting: Flanges with concealed fasteners.
 - 3. Material: Stainless steel, 0.05 inch thick.
 - a. Finish: Smooth, No. 4 finish (satin).
 - 4. Outside Diameter: 1-1/2 inches.
 - 5. Configuration and Length:
 - a. TA - 1A: 12 inches long.
 - b. TA - 1B: 18 inches long.
 - c. TA - 1C: 24 inches long.
 - d. TA - 1D: 30 inches long.
 - e. TA - 1E: 36 inches long.
 - f. TA - 1F: 42 inches long.
 - g. TA - 1G: 48 inches long.
- D. TA-4 Coat Hook:
 - 1. Basis of Design: Bobrick model B-672.
 - 2. Description: Double-prong unit.
 - 3. Material and Finish: Stainless steel, No. 4 finish (satin).
- E. TA-5 Toilet Tissue (Roll) Dispenser:
 - 1. Basis of Design: Bobrick model B-6867.
 - 2. Description: Double-roll dispenser.

3. Mounting: Surface mounted.
4. Operation: Noncontrol delivery with standard spindle.
5. Capacity: Designed for 5-1/2-inch- diameter tissue rolls.
6. Material and Finish: Stainless steel, No. 4 finish (satin).

F. TA-15 Shower Curtain Rod:

1. Basis of Design: Bobrick model B-207.
2. Description: 1-inch OD; fabricated from nominal 0.0375-inch- thick stainless steel.
3. Length: Refer to Drawings.
4. Mounting Flanges: Stainless-steel flanges designed for concealed fasteners.
5. Finish: Stainless steel, No. 4 finish (satin).
6. Shower Curtain Hooks: Chrome-plated or stainless-steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

2.3 PRIVATE-USE BATHROOM ACCESSORIES

- A. Source Limitations: Obtain private-use bathroom accessories from single source from single manufacturer.
- B. TA-19 Toilet Tissue (Roll) Dispenser:
1. Basis of Design: Bobrick model B-6857.
 2. Description: Single-roll dispenser.
 3. Mounting: Surface mounted.
 4. Operation: Noncontrol delivery with standard spindle.
 5. Capacity: Designed for 5-1/2-inch- diameter tissue rolls.
 6. Material and Finish: Stainless steel, No. 4 finish (satin).

2.4 CUSTODIAL ACCESSORIES

- A. Source Limitations: Obtain custodial accessories from single source from single manufacturer.
- B. TA-35 Mop and Broom Holder:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AJW Architectural Products.
 - b. American Specialties, Inc.
 - c. Bobrick Washroom Equipment, Inc.
 - d. Bradley Corporation.
 - e. GAMCO Specialty Accessories; a division of Bobrick.
 2. Basis of Design: Bobrick model B-224 x 36.
 3. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
 4. Length: 36 inches.
 5. Hooks: Three.
 6. Mop/Broom Holders: Four spring-loaded, rubber hat, cam type.
 7. Material and Finish: Stainless steel, No. 4 finish (satin).
 - a. Shelf: Not less than nominal 0.05-inch- thick stainless steel.
 - b. Rod: Approximately 1/4-inch- diameter stainless steel.

2.5 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
- B. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch minimum nominal thickness.
- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating.
- D. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- E. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- F. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).

2.6 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION 102800

SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-protection cabinets for the following:
 - a. Portable fire extinguisher.

B. Related Requirements:

1. Section 104416 "Fire Extinguishers" for portable, hand-carried fire extinguishers accommodated by fire-protection cabinets

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.

B. Shop Drawings: For fire-protection cabinets.

1. Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Initial Selection: For each type of exposed finish required.

D. inches (150 by 150 mm) square.

E. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.2 FIRE-PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Babcock-Davis.
- b. Guardian Fire Equipment, Inc.
- c. J. L. Industries, Inc.; Activar Construction Products Group, Inc.
- d. Larsen's Manufacturing Company.

- B. Cabinet Construction: Nonrated.

- C. Cabinet Material: Cold-rolled steel sheet.

- 1. Shelf: Same metal and finish as cabinet.

- D. Semirecessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).

- E. Cabinet Trim Material: Stainless steel sheet.

- F. Door Material: Stainless steel sheet.

- G. Door Style: Fully glazed panel with frame.

- H. Door Glazing: Tempered float glass (clear).

- I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

- 1. Provide projecting door pull and friction latch.
- 2. Provide continuous hinge, of same material and finish as trim,, permitting door to open 180 degrees.

- J. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.
 - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
 - 1) Location: Applied to cabinet glazing.
 - 2) Application Process: Pressure-sensitive vinyl letters.
 - 3) Lettering Color: Red.
 - 4) Orientation: Vertical.

K. Materials:

1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.
 - a. Finish: Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603.
 - b. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - c. Color: As selected by Architect from manufacturer's full range.
2. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304.
 - a. Finish: ASTM A480/A480M No. 4 directional satin finish,.
3. Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 3 mm

2.3 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 1. Weld joints and grind smooth.
 2. Miter corners and grind smooth.
 3. Provide factory-drilled mounting holes.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
 1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum **1/2 inch (13 mm)** thick.
 2. Fabricate door frames of one-piece construction with edges flanged.
 3. Miter and weld perimeter door frames and grind smooth.

- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where semirecessed cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
 - 1. Fire-Protection Cabinet Mounting Height: **42 inches (1067 mm)** above finished floor to top of fire extinguisher.
- B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
 - 1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semirecessed fire-protection cabinets.
 - 2. Provide inside latch and lock for break-glass panels.
 - 3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.
- B. Related Requirements:
 - 1. Section 104413 "Fire Protection Cabinets."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
- B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function.

1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.5 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:

- a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
 - b. Faulty operation of valves or release levers.
2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Amerex Corporation.
 - b. Ansul; brand of Johnson Controls International plc, Building Solutions North America.
 - c. Badger Fire Protection; a Carrier company.
 - d. J. L. Industries, Inc.; Activar Construction Products Group, Inc.
 - e. Kidde; Carrier Global Corporation.
 - f. Larsen's Manufacturing Company.
 2. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
 3. Valves: Manufacturer's standard.
 4. Handles and Levers: Manufacturer's standard.
 5. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
- B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, **10-lb (4.5-kg)** nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.3 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or **[red]** **[black]** baked-enamel finish.
 - 1. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
 - 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Vertical.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
 - 1. Mounting Height: Top of fire extinguisher to be at **42 inches (1067 mm)** above finished floor.

END OF SECTION 104416

SECTION 105123 - PLASTIC-LAMINATE-CLAD LOCKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Plastic-laminate-clad wood lockers.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of locker.
- B. Sustainable Design Submittals:
1. **Product Data:** For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 2. **Chain-of-Custody Certificates:** For certified wood products. Include statement of costs.
 3. **Chain-of-Custody Qualification Data:** For manufacturer and vendor.
 4. **Laboratory Test Reports:** For composite wood products, indicating compliance with requirements for low-emitting materials.
 5. **Product Data:** For adhesives, indicating VOC content.
 6. **Laboratory Test Reports:** For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For plastic-laminate-clad wood lockers.
1. Include plans, elevations, sections, and attachment details.
 2. Show details full size.
 3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 4. Show locations and sizes of cutouts and holes for items installed in lockers.
 5. Show locker fillers, trim, base, sloping tops, and accessories.
 6. Show locker identification system and numbering sequence.
- D. Samples for Verification: For the following products:
1. Plastic-laminate-clad panels, not less than 8 by 10 inches, for each type, color, pattern, and surface finish.
 2. Thermoset decorative-overlay-surfaced panels, not less than 8 by 10 inches, for each type, color, pattern, and surface finish.
 3. Corner pieces of locker front frame joints between stiles and rail, as well as exposed end pieces, not less than 18 inches wide by 18 inches high by 6 inches deep.
 4. Exposed cabinet hardware and accessories, one unit for each type and finish.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.
- B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver lockers until painting and similar operations that could damage lockers have been completed in installation areas. If lockers must be stored in other-than-installation areas, store only in areas where environmental conditions are the same as those in final installation location, and comply with requirements specified in "Field Conditions" Article.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install lockers until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.
- B. Field Measurements: Where lockers are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings.
 - 1. Locate concealed framing, blocking, and reinforcements that support lockers by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.8 COORDINATION

- A. Coordinate sizes and locations of concealed wood support bases.
 - 1. Requirements are specified in Section 061000 "Rough Carpentry."
- B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that lockers can be supported and installed as indicated.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of lockers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Faulty operation of locks or hardware.
 - c. Deterioration of wood, finishes, and other materials beyond normal use.
 - 2. Warranty Period: Three years from date of Substantial Completion.

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: For lockers indicated to be accessible, comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

2.2 PLASTIC-LAMINATE-CLAD WOOD LOCKERS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [Hollman, Inc.](#)
 - 2. [List Industries Inc.](#)
 - 3. [Treeforms.](#)
- B. **Regional Materials:** Manufacture wood products within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.
- C. **Certified Wood:** Certify wood products as "FSC Pure" or "FSC Mixed Credit" in accordance with FSC STD-01-001 and FSC STD-40-004.
- D. Construction Style: Flush overlay.
- E. Final Assembly: Manufacturer's standard factory assembly.
- F. Locker Body: Fabricated from particleboard-core panels covered on both sides with thermoset decorative overlay.
 - 1. Side Panels: 3/4 inch thick.
 - 2. Back Panel: 1/2 inch thick.
 - 3. Top Panel: 3/4 inch thick.
 - 4. Bottom Panel: 3/4 inch thick.
 - 5. Exposed Panel Edges: High-pressure decorative laminate, Grade HGS, to match panels.
- G. Plastic-Laminate-Clad Wood Doors: High-pressure decorative laminate, Grade VGS, over both sides of particleboard core.
 - 1. Thickness: 3/4 inch thick.
 - 2. Panel Edges: High-pressure decorative laminate, Grade VGS, to match panels.
- H. End Panels: Match style, material, construction, and finish of plastic-laminate-clad wood doors.
- I. Shelves: Fabricated from particleboard-core panels covered on both sides with thermoset decorative overlay; fixed.
 - 1. Thickness: 3/4 inch.
 - 2. Exposed Edges: High-pressure decorative laminate, Grade VGS, to match panels.
 - 3. Exposed Edges: High-pressure decorative laminate, Grade VGS, to match panels.
- J. Corners and Filler Panels: 3/4-inch- thick panels. Match style, material, construction, and finish of plastic-laminate-clad wood doors.

- K. Continuous Finish Base: Plastic-laminate-clad, 3/4-inch- thick panel that matches door faces; fabricated in lengths as long as practical to enclose base and base ends of lockers.
- L. Continuously Sloping Tops: Plastic-laminate-clad, 3/4-inch- thick panel that matches door faces for installation over lockers with separate flat tops. Fabricate tops in lengths as long as practical, without visible fasteners at splice locations. Provide fasteners, supports, and closures, as follows:
 - 1. Closures: Vertical-end type.
- M. Plastic-Laminate Colors, Patterns, and Finishes:
 - 1. Refer to Interior Finish Schedule on Drawing ID001.

2.3 MATERIALS

- A. Composite Wood: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
 - 1. Recycled Content of MDF and Particleboard: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.
 - 2. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.
 - 3. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.
 - 4. Particleboard: ANSI A208.1, Grade M-2.
 - 5. Softwood Plywood: DOC PS 1.
- B. High-Pressure Decorative Laminate: NEMA LD 3, grades as follows:
 - 1. Horizontal Surfaces: Grade HGS.
 - 2. Postformed Surfaces: Grade HGP.
 - 3. Vertical Surfaces: Grade HGS.
- C. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- D. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
- E. Anchors: Material, type, size, and finish as required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- F. Wood Support Base: 2-by-4-inch nominal-size lumber treated with manufacturer's standard preservative-treatment, nonpressure process.

2.4 HARDWARE

- A. Frameless Hinges (European Type): Fully concealed, nickel-plated steel, with not less than 125 degrees of opening.

1. Provide two hinges for doors 36 inches high and less.
 2. Provide three hinges for doors more than 36 inches high.
- B. Wire Pulls: Back mounted; 5 inches long, 2-1/2 inches deep, and 5/16 inch in diameter.
- C. Hooks: Manufacturer's standard, ball-pointed aluminum or steel; chrome finished. Attach hooks with at least two fasteners.
1. Provide hooks as indicated on Drawings.
 2. Provide two single-prong wall hooks for each compartment of double-tier lockers.
- D. Exposed Hardware Finish:
1. Unless otherwise indicated, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
 - a. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.

2.5 FABRICATION

- A. Fabricate each locker with shelves, an individual door and frame, an individual top, a bottom, and a back, and with common intermediate uprights separating compartments.
1. Fabricate lockers to dimensions, profiles, and details indicated.
 2. Ease edges of corners of solid-wood members to 1/16-inch radius.
- B. Fabricate lockers square, rigid, without warp, and with finished faces flat and free of dents, scratches, and chips. Accurately factory machine components for attachments. Make joints tight and true.
1. Fabricate lockers using manufacturer's standard construction, with joints made with dowels, dados, or rabbets. Dado side panels to receive shelving except where indicated to be adjustable.
 2. Fabricate lockers with joints that are dadoed or rabbeted, glued full length, and stapled. Dado side panels to receive shelving except where indicated to be adjustable.
- C. Accessible Lockers: Fabricate as follows:
1. Locate bottom shelf no lower than 15 inches above the floor.
 2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.
- D. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
1. Use only manufacturer's nuts, bolts, screws, and other devices for assembly.
- E. Shop cut openings, to maximum extent possible, to receive hardware, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

3.1 EXAMINATION

- A. Examine walls and floors or support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that furring is attached to concrete and masonry walls that are to receive lockers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Condition lockers to average prevailing humidity conditions in installation areas before installation.
- B. Before installing lockers, examine factory-fabricated work for completeness and complete work as required, including removal of packing.

3.3 INSTALLATION

- A. Install wood support base with 1/2-inch- thick, plywood top.
- B. Install lockers level, plumb, and true; use concealed shims.
- C. Connect groups of lockers together with manufacturer's standard fasteners, through predrilled holes, with no exposed fasteners on face frames. Fit lockers accurately together to form flush, tight, hairline joints.
- D. Install lockers without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings, providing unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 1. Installation Tolerance: No more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line. Shim as required with concealed shims.
- E. Locker Anchorage:
 - 1. Fasten lockers through wood locker base, at ends, and not more than 36 inches o.c. with No. 8 flush-head wood screws sized for 1-inch penetration into wood base.
 - 2. Fasten lockers through back, near top and bottom, at ends with No. 8 flush-head wood screws sized for 1-inch penetration into wood framing, blocking, or furring and spaced not more than 16 inches o.c.
- F. Scribe and cut corner and filler panels to fit adjoining work using fasteners concealed where practical. Repair damaged finish at cuts.
- G. Attach sloping-top units to lockers, with end panels covering exposed ends.

3.4 ADJUSTING

- A. Clean, lubricate, and adjust hardware. Adjust doors to operate easily without binding.

Maryland State Police
Tactical Administration Center
PA-745-210-001

3.5 PROTECTION

- A. Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
- B. Touch up marred finishes, or replace lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 105123

SECTION 109900 - MISCELLANEOUS SPECIALTIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes miscellaneous specialties as scheduled.
- B. Related Sections:
 - 1. Section 055000 - Metal Fabrications: Metal supports.
 - 2. Section 061000 - Rough Carpentry: In-wall framing and plates for support of items scheduled.
 - 3. Section 284000 – Access Control and Alarm Systems: Connection of lock box to security system.

1.3 SUBMITTALS

- A. Product Data: Submit data on miscellaneous specialties describing size, finish, details, and attachment methods. Include sustainable design submittals.
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
- B. Manufacturer's Installation Instructions: Submit special procedures, conditions requiring special attention.

1.4 COORDINATION

- A. Coordinate the Work with placement of internal wall reinforcement and reinforcement of walls to receive anchor attachments.

PART 2 PRODUCTS

2.1 PIPE CLOTHES RACK

- A. Type: Industrial pipe clothes rack.
- B. Material: ASTM A53 Schedule 40 steel.
- C. Hardware: Mounting brackets.
- D. Pipe Diameter: 1" outside diameter.
- E. Rack Capacity: 135 lbs.
- F. Size: 72 inches by 10-1/2".
- G. Supports: 3 extending from wall.
- H. Location: URT Space.
- I. Basis of Design: Crehomfy Industrial Pipe Clothers Rack.

2.2 LOCK BOX

- A. Qualities: 1/4" thick steel lock bock for securing building key for fire department access to building.
- B. Size: 5"H x 4"W x 3-1/4"D.
- C. Mounting: Recess mounted.
- D. Location: As shown.

Maryland State Police
Tactical Administration Center
PA-745-210-001

- E. Source: Model SupraSafe 2HSR/TS by Kidde.
- F. Tamper switch: Provide tamper switch

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify exact location of accessories for installation.
- B. Verify field measurements are as indicated on product data.
- C. Refer to Section 061000 - Rough Carpentry for installation of blocking in wall.
- D. Coordinate with security system for tamper switch connection.

3.2 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.
- C. Prepare tamper switch wiring.

3.3 INSTALLATION

- A. Install items in accordance with manufacturer's instructions and approved submittals.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights and Locations: As required by accessibility regulations or as indicated on Drawings.
- D. Connect tamper switch to building security system.

END OF SECTION

SECTION 111136 - VEHICLE CHARGING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. AC Level 2 electric vehicle supply equipment.

1.2 DEFINITIONS

- A. CCS: Combined charging system; a means for using the same connector port for both AC Level 2 charging and DC Level 2 fast charging.
- B. EV: Electric vehicle.
- C. EVCE: Electric vehicle charging system equipment. This term refers to DC Level 2 charging equipment located off-board the vehicle.
- D. EVSE: Electric vehicle supply equipment. This term refers to AC Level 2 charging equipment that depends on the built-in charger located onboard the vehicle.
- E. Fastened in Place: Does not require tools to be removed and replaced.
- F. Fixed in Place: Requires tools to be removed and replaced.
- G. OCPP: Open Charge Point Protocol; an application protocol for communication between EVs and a central management system.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. AC Level 2 EVSE.
- B. Shop Drawings:
 - 1. Routing and attachment of permanent wiring for AC Level 2 EVSE.
- C. Field quality-control reports.
- D. Sustainable design submittals.

1.4 INFORMATIONAL SUBMITTALS

- A. Preconstruction test reports.

B. Manufacturers' Published Instructions:

1. AC Level 2 EVSE.

C. Manufacturer's Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software and firmware service agreement.

B. Warranty documentation.

C. Sustainable design closeout documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts:

1. UL FFWA - AC Level 2 EV charging station and accessories.

B. Special Tools:

1. UL FFWA - AC Level 2 EV charging station and accessories.

1.7 PRECONSTRUCTION TESTING

A. Wireless Survey: Complete wireless survey to determine if wireless provider signals meet or exceed manufacturer's recommended minimum values.

B. Preconstruction Test Reports: Collect, assemble, and submit test reports prepared by qualified testing agency.

1.8 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed vehicle charging equipment performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that vehicle charging equipment performs in accordance with specified requirements and agrees to provide repair or

replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: Four years from date of Substantial Completion; full coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: Eight years from date of Substantial Completion; prorated coverage for materials only, free on board origin, freight prepaid.

PART 2 - PRODUCTS

2.1 AC LEVEL 2 ELECTRIC VEHICLE SUPPLY EQUIPMENT

- A. Description: EVSE with input rated up to 600 V(ac) for AC Level 2 charging of vehicle batteries using the EV's onboard charger.
- B. Performance Criteria:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 2. Listing Criteria:
 - a. EV Supply Equipment: UL CCN FFWA; including UL 2594.
 - b. Personnel Protection: UL CCN FFUQ2; including UL 2231-1 and UL 2231-2.
 3. General Characteristics: Complying with Article 625 of NFPA 70.
- C. Source Quality Control:
 1. Product Data: Prepare and submit catalog cuts, brochures, diagrams, and performance data illustrating size, physical appearance, and other characteristics of product.
 2. Sustainable Design Submittals: Prepare and submit documentation for the following:
 - a. Provide data indicating vehicle charging equipment complies with requirements for ENERGY STAR product labeling.
 3. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
 - a. Include sample warranty language.
- D. UL FFWA - AC Level 2 EV Charging Station and Accessories
 1. SemaConnect Series 7 or approved equal
 2. Source Limitations: Obtain products from single manufacturer.
 3. Options:
 - a. Location Rating: Indoor/outdoor.

- b. Input Feeder Rating: 208 to 240 V(ac), single phase, 60 Hz, 48 A.
- c. Output Quantity: 2.
- d. Output Wiring: Flexible cord.
 - 1) Output Cable Nominal Length (Usable Length May Be Less): 18 ft (5.5 m).
 - 2) Output Attachment Plug: Type 1 (SAE J1772).
- e. Mounting: Pedestal mount.
- f. Metering: Revenue grade meter.
- g. Networking:
 - 1) Protocol: OCPP.
 - 2) WAN Communications: Cellular LTE.
 - 3) LAN Communications: 802.11 b/g/n WiFi.
 - 4) Capable of remote configuration and reporting.
- h. Authorization or Payment System:
 - 1) RFID reader
 - 2) PCI compliant.
 - 3) Capable of remote control and authorization.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls, floors, and bollards or posts for suitable conditions where vehicle charging equipment will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Shop Drawings: Prepare and submit the following:
 - 1. Routing and attachment of permanent wiring for EVCE.
 - a. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Routing and attachment of permanent wiring for EVCE with bidirectional capability.
 - a. Include plans, elevations, sections, details, and attachments to other work.
 - 3. Routing and attachment of permanent wiring for EVSE.
 - a. Include plans, elevations, sections, details, and attachments to other work.

3.3 INSTALLATION OF VEHICLE CHARGING EQUIPMENT

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation:
 - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with Article 625 of NFPA 70 and with NECA NEIS 413.
 - 2. Consult Architect for resolution of conflicting requirements.
- C. Special Installation Techniques:
 - 1. Hard-Wired Connection: Provide safety switch, that is lockable in "Off" position, in readily accessible location for termination of input cable.
 - 2. 250 V Plug-In Connection:
 - a. Provide 6-50R single receptacle not less than **18 inch (450 mm)** and not more than **4 ft (1.2 m)** above finished floor.
 - b. Remove plug and providesafety switch, that is lockable in "Off" position, in readily accessible location for termination of input cable.
 - 3. Fastened in Place: Comply with manufacturer's published instructions for installing mounting hardware. Provide manufacturer's recommended seismic controls when required for compliance with Section 260011 "Facility Performance Requirements for Electrical."
 - 4. Fixed in Place: Comply with manufacturer's published instructions for installation and torqueing of hardware fasteners. Provide manufacturer's recommended seismic controls when required for compliance with Section 260011 "Facility Performance Requirements for Electrical."
 - 5. Base Mounting: When indicated on Drawings or in manufacturer's published instructions, provide housekeeping pad for installing base for vehicle charging equipment.
 - 6. Identification: Provide labels for vehicle charging equipment and associated electrical equipment.
 - a. Identify field-installed conductors, interconnecting wiring, and components.
 - b. Provide warning signs.
 - c. Label each enclosure with engraved metal or laminated-plastic nameplate.
- D. Cybersecurity:
 - 1. Software:
 - a. Coordinate security requirements with IT department.
 - b. Ensure that latest stable software release is installed and properly operating.
 - c. Disable or change default passwords to password of at least eight characters in length, using a combination of uppercase and lower letters, numbers, and symbols. Record passwords and turn over to party responsible for system operation and administration.

2. Hardware:
 - a. Coordinate location and access requirements with IT department.
 - b. Enable highest level of wireless encryption that is compatible with Owner's information and communications technology network.
 - c. Disable dual network connections.

3.4 FIELD QUALITY CONTROL OF VEHICLE CHARGING EQUIPMENT

- A. Field tests and inspections must be witnessed by Tenant.
- B. Tests and Inspections:
 1. Perform manufacturer's recommended tests and inspections.
 2. For each unit of vehicle charging equipment, perform the following tests and inspections:
 - a. Unit self-test.
 - b. Operation test with load bank.
 - c. Operation test with EV.
 - d. Network communications test.
- C. Nonconforming Work:
 1. Unit will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective units and retest.
- D. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.
- E. Manufacturer Services: Engage factory-authorized service representative to supervise field tests and inspections.
 1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.5 SYSTEM STARTUP

- A. Perform startup service.
 1. Complete installation and startup checks in accordance with manufacturer's published instructions.
- B. Manufacturer Services: Engage factory-authorized service representative to support system startup.
 1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.6 CLOSEOUT ACTIVITIES

A. Sustainable Design Closeout Documentation:

1. Installed EV Infrastructure Documentation:

- a. Provide drawings showing location and number of EV charging units, charging levels and connectors, and ability of EV charging units to participate in a demand-response or time-of-use pricing program.

3.7 PROTECTION

- #### A. After installation, protect vehicle charging equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Software and Firmware Service Agreement:

1. **Technical Support:** Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for two years.
2. **Upgrade Service:** At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within two years from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.
 - a. **Upgrade Notice:** No fewer than 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.
3. **Upgrade Reports:** Prepare report after each update, documenting upgrades installed.

END OF SECTION 111136

SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manually operated roller shades with single rollers.
 - 2. Motor-operated roller shades with single rollers.
- B. Related Sections:
 - 1. Section 061000 "Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
- B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
 - 1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.
- C. Samples for Verification: For each type of roller shade.
 - 1. Shadeband Material: Not less than 3 inches square. Mark interior face of material if applicable.
- D. Product Schedule: For roller shades.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.8 WARRANTY

- A. Roller Shade Hardware and Chain Warranty: 10 years.
- B. Shadecloth: 25 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide FlexShades CLN by Draper Inc. or comparable product by one of the following:
 - 1. Hunter Douglas Contract
 - 2. Mecho Shade.
 - 3. Lutron Electronics Co. Inc.
 - 4. Springs Window Fashions; SWF contract.
- B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 - 1. Bead Chains: Nickel-plated metal.
 - a. Loop Length: Full length of roller shade.
 - b. Limit Stops: Provide upper and lower ball stops.
 - c. Chain-Retainer Type: Clip, jamb mount.
 - 2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.
 - a. Provide for shadebands that weigh more than 10 lb or for shades as recommended by manufacturer, whichever criterion is more stringent.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
 - 1. Roller Drive-End Location: Right side of interior face of shade.

2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- F. Installation Accessories:
1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 3 inches.
 2. Endcap Covers: To cover exposed endcaps.
 3. Installation Accessories Color and Finish: Clear anodized.

2.3 MOTORIZED WINDOW SHADES

- A. Type: UL listed, motorized, vertical roll-up, fabric window shade with motors, controls, mounting brackets, and other components necessary for complete installation.
1. Endcaps and fascia.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Motorized FlexShades 485 AC by Draper Inc. or comparable product by one of the following:
1. Hunter Douglas Contract
 2. Mecho Shade.
 3. Lutron Electronics Co. Inc.
 4. Springs Window Fashions; SWF contract.
- C. Shade Motor and Control System:
1. 120V AC Intelligent Technology motor with built-in low voltage controller with 3-wire pig tail and data cable. No external motor controls are required. Available with optional three prong plug. Tubular motor concealed inside each shade roller tube.
 2. Individual Control, Group Control & Individual and Group Control: 6 button RS 485 switch- for 2 groups up/stop/down or 1 group up/stop/down and 3 presets.
 3. Basis of Design: Draper Motorized FlexShade® I/O AC.
- D. Configuration: Single Roller.
1. Mounting.
 - a. Endcaps: Stamped steel with universal design suitable for mounting to ceiling, wall, and jamb. Provide size compatible with roller size. Endcap covers to match fascia/headbox finish.
 - b. Fascia: L shaped aluminum extrusion to conceal shade roller and hardware.
 - 1) Attachment: Snaps onto end caps without requiring exposed fasteners of any kind. Fascia can be mounted continuously across two or more shade bands.
 - 2) Finish: Selected from Manufacturers standard range.

2. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
- E. Flat exposed hem bar: 7/8 inch x 5/16 inch aluminum rectangular hem bar with plastic end caps.
 - F. Roller: Fabricated from extruded aluminum or steel. Wall thickness and material selected by manufacturer to accommodate shade size. Provide with roller idler assembly of molded nylon and zinc-plated steel pin. Sliding pin to allow easy installation and removal of roller. Fabric connected to the roller tube with LSE (low surface energy) double sided adhesive specifically developed to attach coated textiles to metal. Adhesive attachment to eliminate horizontal impressions in fabric.
 - G. Coupling system: Couplings to join motorized shade rollers to allow operation by single motor. FlexShade Coupling System as manufactured by Draper, Inc. Provide endcaps to receive couplers and support multiple shades. Coupling system must be capable of up to 30-degree angles.
 - H. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
 1. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than 4 inches.
 2. Provide pocket with lip at lower edge to support acoustical ceiling panel.

2.4 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering and Blackout Fabric (WT-1 and WT-2): Woven fabric, stain and fade resistant.
 1. Source: Roller shade manufacturer.
 2. Orientation on Shadeband: Up the bolt.
 3. Basis of Design: Refer to Interior Finish Schedule on Drawing ID001.

2.5 ROLLER SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes:
 1. Window Mount: Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
 2. Recessed Ceiling Mount: Single shade, width as indicated on Drawings.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:

1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, locations of connections to building electrical system and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
 1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.
- B. Electrical Connections: Connect motor-operated roller shades to building electrical system.
- C. Locations:
 1. Motorized operating mechanism at Training Room 145, and Conference Room 141.
 2. Manual, chain-and-clutch operating mechanism all other exterior windows.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION 122413

SECTION 123216 - MANUFACTURED PLASTIC-LAMINATE-CLAD CASEWORK

PART 1 - GENERAL

A. Section Includes:

1. Plastic-laminate-clad casework.
2. Casework hardware and accessories.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking for anchoring casework.
2. Section 096513 "Resilient Base and Accessories" for resilient base applied to plastic-laminate-clad casework.
3. Section 123661.16 "Solid Surface Countertops."

1.2 DEFINITIONS

- #### A. Definitions in the AWI/AWMAC/WI's "Architectural Woodwork Standards" apply to the Work of this Section.

1.3 PREINSTALLATION MEETINGS

- #### A. Preinstallation Conference: Conduct conference at Project site.

1.4 COORDINATION

- #### A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that casework can be supported and installed as indicated.

1.5 ACTION SUBMITTALS

- #### A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. [Product Data](#): For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. [<Double click to insert sustainable design text for regional materials.>](#)
3. [Chain-of-Custody Certificates](#): For certified wood products. Include statement of costs.
4. [Chain-of-Custody Qualification Data](#): For manufacturer and vendor.
5. [Laboratory Test Reports](#): For adhesives, indicating compliance with requirements for low-emitting materials.
6. [Laboratory Test Reports](#): For composite wood products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For plastic-laminate-clad casework.

1. Include plans, elevations, sections, and attachments to other work including blocking and reinforcements required for installation.
2. Indicate types and sizes of casework.
3. Indicate manufacturer's catalog numbers for casework.
4. Show fabrication details, including types and locations of hardware.

5. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and equipment.
 - D. Keying Schedule: Include schematic keying diagram, and index each key set to unique designations that are coordinated with the Contract Documents.
 - E. Samples: For casework and hardware finishes.
 - F. Samples for Verification: For the following:
 1. Plastic Laminates: 8 by 10 inches, for each type, color, pattern, and surface finish required.
 - a. Provide one Sample applied to core material with specified edge material applied to one edge.
- 1.6 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For casework manufacturer.
 - B. Sample Warranty: For special warranty.
- 1.7 QUALITY ASSURANCE
- A. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.
 - B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.
 - C. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.
- 1.9 FIELD CONDITIONS
- A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during remainder of construction period.
 - B. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.
 - C. Field Measurements: Where casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.

- D. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before enclosing them, and indicate measurements on Shop Drawings.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Delamination of components or other failures of glue bond.
 - b. Warping of components.
 - c. Failure of operating hardware.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Refer to Interior Finish Schedule on Drawing ID001.
- B. Source Limitations: Obtain from single source from single manufacturer.

2.2 GENERAL REQUIREMENTS FOR CASEWORK

- A. Quality Standard: Unless otherwise indicated, comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.
 - 1. Grade: Custom.
- B. **Regional Materials:** Manufacture wood products within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.
- C. **Certified Wood:** Certify wood products as "FSC Pure"[or "FSC Mixed Credit"] in accordance with FSC STD-01-001 and FSC STD-40-004.
- D. Product Designations: Drawings indicate configurations of manufactured plastic-laminate-clad casework by referencing designations of Casework Design Series numbering system in the Appendix of the AWI/AWMAC/WI's "Architectural Woodwork Standards."

2.3 PLASTIC-LAMINATE-CLAD CASEWORK

- A. Design: Frameless cabinet construction with the following door and drawer-front style:
 - 1. Flush overlay.
- B. Grain Direction for Wood-Grain Plastic Laminate:
 - 1. Doors: Vertical with continuous vertical matching.
 - 2. Drawer Fronts: Vertical with continuous vertical matching.
 - 3. Face Frame Members: Lengthwise.
 - 4. End Panels: Vertical.
 - 5. Bottoms and Tops of Units: Side to side.
 - 6. Knee Space Panels: Vertical.

7. Aprons: Horizontal.

C. Exposed Materials:

1. Plastic-Laminate Grade:
 - a. Counter-Tops: HGS, 1.2mm.
 - b. Vertical Surfaces: HGL, 1.0 mm.
 - c. Interior Surfaces: VGS, 0.7 mm.
 - d. Colors and Patterns: Refer to Interior Finish Schedule on Drawing ID001.
2. Solid Wood: Clear hardwood lumber of species indicated, selected for compatible grain and color.
 - a. Wood Species: White maple.
 - b. Wood Finish: Match Architect's sample.

D. Semiexposed Materials:

1. Plastic Laminate: Grade VGS unless otherwise indicated. Provide plastic laminate for semiexposed surfaces unless otherwise indicated.
 - a. Colors and Patterns: Refer to Interior Finish Schedule on Drawing ID001.
 - b. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.
2. Thermoset Decorative Panels: Provide thermoset decorative panels for semiexposed surfaces unless otherwise indicated.
 - a. Colors and Patterns: As selected by Architect from manufacturer's full range.
 - b. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.
3. Hardboard: Use only for cabinet backs where exterior side of back is not exposed.
4. Unless otherwise indicated, provide specified edgework on all semiexposed edges.

E. Concealed Materials:

1. Solid Wood: With no defects affecting strength or utility.
2. Plywood: Hardwood plywood.
3. Plastic Laminate: Grade BKL.
4. Particleboard.

2.4 CABINET HARDWARE AND ACCESSORIES

A. Hardware, General: Unless otherwise indicated, provide manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware.

1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where hardware is through-bolted from back side.

B. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, Type B01602, self-closing. Provide two hinges for doors less than 48 inches high, and provide three hinges for doors more than 48 inches high.

1. Degrees of Opening: 100 degrees.

C. Wire Pulls: Solid aluminum stainless steel or chrome-plated brass wire pulls, fastened from back with two screws.

1. For sliding doors, provide recessed stainless steel or chrome-plated flush pulls.
2. Provide two pulls for drawers more than 24 inches wide.

- D. Semirecessed Pulls: Plastic. For sliding doors, provide recessed plastic flush-pulls. Provide two pulls for drawers more than 24 inches wide.
- E. Door and Drawer Bumpers: Self-adhering, clear silicone rubber.
 - 1. Doors: Provide one bumper at top and bottom of closing edge of each swinging door.
 - 2. Drawers: Provide one bumper on back side of drawer front at each corner.
- F. Drawer Slides: ANSI/BHMA A156.9, Type B05091.
 - 1. Standard Duty (Grade 1, Grade 2, and Grade 3): Side mounted.
 - a. Extension Type: Full.
 - b. Material: Zinc-plated steel with polymer rollers.
 - 2. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated, steel ball-bearing slides.
 - 3. Box Drawer Slides: Grade 1, for drawers not more than 6 inches high and 24 inches wide.
 - 4. File Drawer Slides: Grade 1HD-100, for drawers more than 6 inches high or 24 inches wide.
 - 5. Pencil Drawer Slides: Grade 1, for drawers not more than 3 inches high and 24 inches wide.
 - 6. Keyboard Slides: Grade 1, for computer keyboard shelves.
- G. Drawer and Hinged-Door Locks: Cylindrical (cam) type, five-pin tumbler, brass with chrome-plated finish, and complying with ANSI/BHMA A156.11, Grade 1.
 - 1. Provide a minimum of two keys per lock and six master keys.
 - 2. Provide locks where indicated.
 - a. Masterkey for up to 500 key changes.
- H. Adjustable Shelf Supports: Single-pin metal shelf rests complying with ANSI/BHMA A156.9, Type B04013.

2.5 MATERIALS

- A. Composite Wood Products: Verify products are made using ultra-low-emitting formaldehyde resins, as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.
- B. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.
- C. Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated.
- D. Softwood Plywood: DOC PS 1.
- E. Particleboard: ANSI A208.1, Grade M-2.
- F. MDF: Medium-density fiberboard, ANSI A208.2, Grade 130.
- G. Hardboard: ANSI A135.4, Class 1 tempered.
- H. Plastic Laminate: High-pressure decorative laminate complying with NEMA LD 3.
 - 1. Source Limitations: Obtain from single source from single manufacturer.

2. Basis of Design: Refer to Interior Finish Schedule on Drawing ID001.

- I. Thermoset Decorative Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.
 - 1. Edgebanding for Thermoset Decorative Panels: PVC or polyester edgebanding matching thermoset decorative panels.
- J. **Adhesives:** Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.6 FABRICATION

- A. Plastic-Laminate-Clad Cabinet Construction: As required by referenced quality standard, but not less than the following:
 - 1. Bottoms and Ends of Cabinets, and Tops of Wall Cabinets and Tall Cabinets: 3/4-inch particleboard.
 - 2. Shelves: 3/4-inch thick particleboard.
 - 3. Backs of Casework: 1/2-inch- thick particleboard or MDF where exposed, 1/4-inch- thick hardboard dadoed into sides, bottoms, and tops where not exposed.
 - 4. Drawer Fronts: 3/4-inch particleboard.
 - 5. Drawer Sides and Backs: 1/2-inch- thick particleboard or MDF, with glued dovetail or multiple-dowel joints.
 - 6. Drawer Bottoms: 1/4-inch- thick hardwood plywood glued and dadoed into front, back, and sides of drawers. Use 1/2-inch material for drawers more than 24 inches wide.
 - 7. Doors 48 Inches High or Less: 3/4 inch thick, with particleboard or MDF cores and solid-wood stiles and rails.
 - 8. Doors More Than 48 Inches High: 1-1/16 inches thick, with solid hardwood stiles and rails and honeycomb cores.
- B. Filler Strips: Provide as needed to close spaces between casework and walls, ceilings, and equipment. Fabricate from same material and with same finish as casework.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Grade: Install casework to comply with same quality standard grade as item to be installed.
- B. Install casework level, plumb, and true in line; shim as required using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.

- C. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch of a single plane. Align similar adjoining doors and drawers to a tolerance of 1/16 inch. Bolt adjacent cabinets together with joints flush, tight, and uniform.
- D. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within 1/16 inch of a single plane. Fasten cabinets to hanging strips, masonry, framing, wood blocking, or reinforcements in walls and partitions. Align similar adjoining doors to a tolerance of 1/16 inch.
- E. Fasten casework to adjacent units and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards."
- F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.
- G. Adjust operating hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.3 CLEANING

- A. Repair or remove and replace defective work as directed on completion of installation.
- B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION 123216

SECTION 123553.13 - METAL LABORATORY CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Stainless steel laboratory casework.
 2. Filler and closure panels.
 3. Laboratory countertops.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For laboratory casework. Include plans, elevations, sections, and attachments to other work including blocking and reinforcements required for installation.

1.3 INFORMATIONAL SUBMITTALS

- A. Product test reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Mott Manufacturing Ltd.
 2. Kewaunee Scientific Corp.
 3. MultiLab LLC.

2.2 METAL CASEWORK MATERIALS

- A. Steel Sheet: Cold-rolled, commercial steel (CS) sheet, complying with ASTM A1008/A1008M; matte finish; suitable for exposed applications.
- B. Stainless Steel: ASTM A666, Type 304 commercial grade, No. 4 finish in 12, 16, 18 and 20 gauge.

2.3 CABINET HARDWARE

- A. General: Provide laboratory casework manufacturer's standard, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.
- B. Hinges: Stainless-steel, five-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips.
- C. Hinged-Door and Drawer Pulls: Solid stainless steel, back-mounted pulls.
- D. Door Catches: A two-piece heavy-duty cam action positive catch.

- E. Drawer Slides: Manufacturer's standard.

2.4 COUNTERTOP MATERIALS

- A. Stainless Steel Sheet: ASTM A240/A240M, Type 304, 18 gauge.

2.5 METAL CABINETS

- A. Casework Fabrication: Die-formed metal sheet; each unit self-contained and not dependent on adjacent units or building structure for rigidity; factory-fabricated, factory-assembled, and factory-finished.
 - 1. Style: Flush overlay – square edge.
 - 2. Structural Performance: Provide components that safely support the following minimum loads, without deformation or damage:
 - a. Base Units: Uniformly distributed load 200 pounds per square foot of cabinet top area.
 - b. Base cabinet leveling bolts shall support 500 pounds per corner.
 - 3. Corners and Joints: Without gaps or inaccessible spaces or areas where dirt or moisture could accumulate.
 - 4. Edges and Seams: Smooth. Form counter tops, shelves, and drain boards from continuous sheets.
 - 5. Shelf Edges: Turned down 3/4 inch on each side and returned 3/4 inch front and back.
 - 6. Ends: Close open ends with matching construction.
 - 7. Welding: Electric spot welded; joints ground smooth and flush.
 - 8. Flush Doors: Outer and inner pans that nest into box formation, with full-height channel reinforcements at center of door. Fill doors with noncombustible, sound-deadening material.
- B. Steel Gauges: Gauges of steel used in construction of cases shall be 18 gauge, except as follows:
 - 1. Leveling bolt reinforcements 12 gauge.
 - 2. Top and intermediate front horizontal rails, apron rails, hinge reinforcements, and reinforcement gussets, 16 gauge.
 - 3. Drawer assemblies, door assemblies, bottom, bottom back rail, toe space rail, and adjustable shelves, 20 gauge.
- C. Hinged Doors: Mortise for hinges and reinforce with angles welded inside inner pans at hinge edge.
- D. Drawers: Fronts made from outer and inner pans that nest into box formation, without raw metal edges at top. Sides, back, and bottom fabricated in one piece with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal. Provide drawers with rubber bumpers, polymer roller slides, and positive stops to prevent metal-to-metal contact or accidental removal.
- E. Adjustable Shelves: Front, back, and ends formed down, with edges returned horizontally at front and back to form reinforcing channels.
- F. Toe Space: Fully enclosed, 4 inches high by 3 inches deep, with no open gaps or pockets.

- G. Filler and Closure Panels: Provide where indicated and as needed to close spaces between casework and walls, ceilings, and equipment. Fabricate from same material and with same finish as casework and with hemmed or flanged edges unless otherwise indicated.
- H. Label Holders: Stainless steel, aluminum, or chrome plated; sized to receive standard label cards approximately 1 by 2 inches, attached with screws or rivets. Provide on drawers.

2.6 COUNTERTOPS

- A. Countertops, General: Provide units with smooth surfaces in uniform plane, free of defects. Make exposed edges and corners straight and uniformly beveled. Provide front and end overhang of 1 inch.
- B. Stainless Steel Countertops: Made from stainless steel sheet, not less than 0.062-inch nominal thickness, with No. 4 satin finish.
 - 1. Extend top down 1 inch at edges with a 1/2-inch return flange under frame. Apply heavy coating of heat-resistant, sound-deadening mastic to undersurface.
 - 2. Form backsplash coved to and integral with top surface.
 - 3. Provide raised (marine) edge around perimeter of all countertops.
 - 4. Reinforce underside of countertop with channels or use thicker metal sheet where necessary to ensure rigidity without deflection.
 - 5. Weld shop-made joints.
 - 6. Where field-made joints are required, provide hairline butt joints mechanically bolted through continuous channels welded to underside at edges of joined ends. Keep field jointing to a minimum.
 - 7. After fabricating and welding, grind surfaces smooth and polish to produce uniform, directionally textured finish with no cross scratches or evidence of welds. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.

PART 3 - EXECUTION

3.1 INSTALLATION OF CABINETS

- A. Comply with manufacturers installation requirements. Install level, plumb, and true in line; shim as required using concealed shims. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- B. Base Cabinets: Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions, with fasteners spaced not more than 16 inches o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform.
- C. Wall Cabinets: Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 16 inches o.c.
- D. Install hardware uniformly and precisely.
- E. Adjust operating hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.2 INSTALLATION OF COUNTERTOPS

- A. Field Jointing: Where possible, make in same manner as shop-made joints, using dowels, splines, fasteners, adhesives, and sealants recommended by manufacturer. Shop prepare edges for field-made joints.
- B. Fastening:
 - 1. Secure countertops, except for epoxy countertops, to cabinets with Z-type fasteners or equivalent, using two or more fasteners at each cabinet front, end, and back.
 - 2. Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at not more than 48 inches o.c.
 - 3. Where necessary to penetrate countertops with fasteners, countersink heads approximately 1/8 inch and plug hole flush with material equal to countertop in chemical resistance, hardness, and appearance.
- C. Provide holes and cutouts required for service fittings.
- D. Dress joints smooth, remove surface scratches, and clean entire surface.

3.3 INSTALLATION OF SINKS

- A. Semiflush Installation of Stainless Steel Sinks: Before setting, apply sink and countertop manufacturers' recommended sealant under rim lip and along top. Remove excess sealant while still wet and finish joint for neat appearance.

3.4 CLEANING AND PROTECTING

- A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- B. Protect countertop surfaces during construction with 6-mil plastic or other suitable water-resistant covering. Tape to underside of countertop at a minimum of 48 inches o.c.

END OF SECTION 123553.13

SECTION 123619 - WOOD COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Wood countertops.

1.2 ACTION SUBMITTALS

- A. Sustainable Design Submittals:
1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
 3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 4. Product Data: For installation adhesives, indicating VOC content.
 5. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.
- B. Shop Drawings: For wood countertops.
1. Include plans, sections, details, and attachments to other work. Detail fabrication and installation, including field joints.
 2. Show locations and sizes of cutouts and holes for items installed in wood countertops.
- C. Samples: For each shop-applied transparent finish and for each color and wood species specified, in manufacturer's or fabricator's standard size.
- D. Samples for Verification: For the following:
1. Lumber for Transparent Finish: Not less than 3 inches wide by 4 inches long, for each species and cut, finished on one side and one edge.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For the following:
1. Composite wood products.
 2. Adhesives.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver countertops only after casework and supports on which they will be installed have been completed in installation areas.

- B. Store countertops in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.
- C. Keep finished surfaces of countertops covered with protective covering during handling and installation.

1.6 FIELD CONDITIONS

- A. Environmental Limitations without Humidity Control: Do not deliver or install wood countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Environmental Limitations with Humidity Control: Do not deliver or install wood countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.
- C. Field Measurements: Where wood countertops are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- D. Established Dimensions: Where wood countertops are indicated to fit to other construction, establish dimensions for areas where wood countertops are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 WOOD COUNTERTOPS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of wood countertops indicated for construction, finishes, installation, and other requirements.
 - 1. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.
- B. Grade: Custom.
- C. **Regional Materials**: Manufacture wood products within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.
- D. **Certified Wood**: Certify wood products as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004.
- E. Butcher-Block Countertops: For transparent finish. Fabricated from narrow strips of lumber glued together and arranged for random mix of color and grain.
 - 1. Wood Species: Hard maple.

2. Strip Thickness: 1-1/2 inches.

2.2 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of wood countertop and quality grade specified unless otherwise indicated.
 1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches wide.
 2. Wood Moisture Content: 5 to 10 percent.

2.3 ACCESSORIES

- A. Wire-Management Grommets: Circular, molded-plastic grommets and matching plastic caps with slot for wire passage.
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. **Doug Mockett & Company, Inc.**
 2. Outside Diameter: 1-1/4 inches.
 3. Color: Black.

2.4 MISCELLANEOUS MATERIALS

- A. **Adhesives:** Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Installation Adhesive:
 1. **Verify adhesives have a VOC** content of 70 g/L or less.
 2. **Verify adhesive complies with the** testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 FABRICATION

- A. Fabricate wood countertops and back-splashes to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
 1. Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.
 2. Edges of Members More Than 3/4 Inch Thick: 1/8 inch.
- B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

- C. Shop cut openings to maximum extent possible to receive appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 - 1. Seal edges of openings in countertops with a coat of varnish.

2.6 SHOP FINISHING

- A. General: Finish wood countertops at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
- B. Finish Materials: Use finish materials that comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Transparent Finish:
 - 1. Grade: Custom.
 - 2. Finish: System - 5, conversion varnish.
 - 3. Staining: None required.
 - 4. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
 - 5. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter in accordance with ASTM D523.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition wood countertops to average prevailing humidity conditions in installation areas for not less than 72 hours.
- B. Before installing wood countertops, examine shop-fabricated work for completion and complete work as required, including removal of packing and application of backpriming.

3.2 INSTALLATION

- A. Grade: Install wood countertops to comply with same grade as item to be installed.
- B. Assemble wood countertops and complete fabrication at Project site to the extent that it was not completed in the shop.
- C. Field Jointing: Where possible, make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.
 - 1. Secure field joints in countertops with concealed clamping devices located within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten in accordance with manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.
- D. Scribe and cut wood countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

- E. Countertop Installation: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Install countertops level and true in line. Use concealed shims as required to maintain not more than a 1/8-inch-in-96-inches variation from a straight, level plane.
 - 2. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive.
 - 3. Seal joints between countertop and backsplash, and joints where countertop and backsplash abut walls with sealant specified in Section 079200 "Joint Sealants."
- F. Shop Finishes: Touch up finishing after installation of wood countertops.
 - 1. Apply specified finish coats to exposed surfaces where only sealer/prime coats are shop applied.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective wood countertops, where possible, to eliminate functional and visual defects. Where not possible to repair, replace countertops. Adjust joinery for uniform appearance.
- B. Clean wood countertops on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.
- C. Protection: Provide Kraft paper or other suitable covering over countertop surfaces, taped to underside of countertop at a minimum of 48 inches o.c. Remove protection at Substantial Completion.

END OF SECTION 123619

SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Solid surface material countertops.
 2. Solid surface material backsplashes.
 3. Solid surface material apron fronts.
 4. Solid surface material sinks.
 5. Solid surface windowsills.

1.2 ACTION SUBMITTALS

- A. Product Data: For countertop and windowsill materials and sinks.
- B. Sustainable Design Submittals:
1. [Chain-of-Custody Certificates](#): For certified wood products. Include statement of costs.
 2. [Product Data](#): For adhesives, indicating VOC content.
 3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 4. [Laboratory Test Reports](#): For composite wood products, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For countertops and windowsills. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
1. Show locations and details of joints.
 2. Show direction of directional pattern, if any.
- D. Samples for Verification: For the following products:
1. Countertop material, 6 inches square.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.

- B. Installer Qualifications: Fabricator of countertops.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements before countertop fabrication is complete.

1.7 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP AND WINDOWSILL MATERIALS

- A. Solid Surface Material: Homogeneous-filled plastic resin complying with ISFA 2-01.
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [DuPont; DuPont de Nemours, Inc.](#)
 - b. [Formica Corporation.](#)
 - c. [LG Hausys, Ltd.](#)
 - d. [Wilsonart LLC.](#)
 - 2. Type: Provide Standard type unless Special Purpose type is indicated.
 - 3. Integral Sink Bowls: Comply with CSA B45.5/IAPMO Z124.
 - 4. Colors and Patterns: Refer to Interior Finish Schedule on Drawing ID001.
- B. **Composite Wood Products:** Verify products are made using ultra-low-emitting formaldehyde resins, as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products," or are made with no added formaldehyde.
- C. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 - 1. Grade: Custom.
- B. Configuration:
 - 1. Front: Straight, slightly eased at top with separate apron, height as indicated, recessed 1/4-inch behind front edge where indicated.
 - 2. Backsplash: Straight, slightly eased at corner.
- C. Countertops: 1/2-inch- thick, solid surface material.
- D. Windowsills with Apron: 1/2-inch- thick, solid surface material.
- E. Backsplashes: 1/2-inch- thick, solid surface material.

- F. Fabricate tops with shop-applied edges unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate with loose backsplashes for field assembly.
 - 2. Install integral sink bowls in countertops in the shop.
- G. Joints:
 - 1. Fabricate countertops without joints.
- H. Cutouts and Holes:
 - 1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.
 - b. Provide vertical edges, rounded to 3/8-inch radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch into fixture opening.
 - c. Provide 3/4-inch full bullnose edges projecting 3/8 inch into fixture opening.
 - 2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
 - 3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by solid surface material manufacturer.
 - 1. [Verify adhesives have a VOC](#) content of 70 g/L or less.
 - 2. [Verify adhesive complies with the](#) testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.

- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- D. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 - 1. Install metal splines in kerfs in countertop edges at joints. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
 - 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- G. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Pre-drill holes for screws as recommended by manufacturer.
- H. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
 - 1. Seal edges of cutouts in particleboard subtops by saturating with varnish.
- I. Install window sills by adhering to substrate with adhesive. Mask areas adjacent to joints to prevent adhesive smears.
- J. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16

SECTION 123661.19 - QUARTZ AGGLOMERATE COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Quartz agglomerate countertops.
 - 2. Quartz agglomerate backsplashes.
 - 3. Quartz agglomerate apron fronts.
- B. Related Requirements:
 - 1. Section 224100 "Residential Plumbing Fixtures" for sinks and plumbing fittings.

1.2 ACTION SUBMITTALS

- A. Product Data: For countertop materials.
- B. Sustainable Design Submittals:
 - 1. [Product Data](#): For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
 - 1. Show direction of directional pattern, if any.
- D. Samples for Verification: For the following products:
 - 1. Countertop material, 6 inches square.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For quartz agglomerate countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of countertops.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements before countertop fabrication is complete.

1.7 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 QUARTZ AGGLOMERATE COUNTERTOP MATERIALS

- A. Quartz Agglomerate: Solid sheets consisting of quartz aggregates bound together with a matrix of polymers, resins, and pigment and complying with ISFA 3-01.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cambria.
 - b. DuPont; DuPont de Nemours, Inc.
 - c. LG Hausys, Ltd.
 - d. Wilsonart LLC.
 2. Colors and Patterns: Refer to Interior Finish Legend on Drawing ID001.
- B. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.
- C. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 FABRICATION

- A. Fabricate countertops according to quartz agglomerate manufacturer's written instructions and the AWI/AWMAC/WI's "Architectural Woodwork Standards."
1. Grade: Custom.
- B. Configuration:
1. Front: Straight, slightly eased at top with separate apron, height as indicated, recessed 1/4-inch behind front edge where indicated.
 2. Backsplash: Straight, slightly eased at corner.
- C. Countertops: 1/2-inch- thick, quartz agglomerate with front edge built up with same material.
- D. Backsplashes: 1/2-inch- thick, quartz agglomerate.
1. Provide full height backsplash to underside of cabinet where indicated.
- E. Fabricate tops with shop-applied edges unless otherwise indicated. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
1. Fabricate with loose backsplashes for field assembly.

- F. Joints:
 - 1. Fabricate countertops without joints.

- G. Cutouts and Holes:
 - 1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.
 - b. Provide vertical edges, rounded to 3/8-inch radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch into fixture opening.
 - c. Provide 3/4-inch full bullnose edges projecting 3/8 inch into fixture opening.
 - 2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
 - 3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by quartz agglomerate manufacturer.
 - 1. [Verify adhesives have a VOC](#) content of 70 g/L or less.
 - 2. [Verify adhesive complies with the](#) testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

- B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive quartz agglomerate countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.

- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

- C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- D. Secure countertops to subtops with adhesive according to quartz agglomerate manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- E. Install backsplashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- F. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
- G. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
 - 1. Seal edges of cutouts in particleboard subtops by saturating with varnish.
- H. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.19

SECTION 131900- KENNEL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fabricated kennel enclosures
 - 2. Kennel accessories
 - 3. Dog grooming equipment

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control booths.
 - 2. Include plumbing connections
 - 3. Include plans, elevations, sections, details, accessories, and fastening and anchorage details, including mechanical fasteners.
- B. Samples: For exposed wire enclosure mesh, approximately 8-1/2 by 11 inches (215 by 280 mm) in size.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For kennel enclosures and equipment to include in maintenance manuals.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FABRICATED KENNEL ENCLOSURES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide [Shor-Line Inc.](#); custom kennel enclosure:
- B. Materials: Stainless steel wire panel enclosures with 1-1/4" x 6" wire spacing in 1-1/4" stainless steel frames. Run gates shall be 30" x 84", with food and water bowls. Provide side panels to match doors.
- C. Hardware: Self-locking latches at indoor and outdoor runs, with carabiner safety.
- D. Transfer Doors: Cable-operated insulated aluminum doors in sliding tracks. Cables shall be routed to allow operation without contact with kennel occupants.
- E. Drain covers: Stainless steel covers over indoor and outdoor trench drains.
- F. Feeders: Slotting stainless steel feeder assembly for two 2-quart bowls at indoor runs, built into doors.

2.2 DOG GROOMING EQUIPMENT

- A. Basis-of-Design Product: Subject to compliance with requirements, provide [Shor-Line Inc.](#); "Elite Grooming Shower"
- B. Materials: Stainless steel construction, PVC drain boards
- C. Utilities: Provide tempered supply, wash hose, and drain
- D. Accessories: Tools shelf, restraining rails and clips

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, including concrete bases; accurate placement, pattern, and orientation of anchor bolts; critical dimensions; and other conditions affecting performance of the Work.
- B. Examine roughing-in for plumbing systems.

- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install kennel equipment in accordance with manufacturer's written instructions.
- B. Set kennel equipment plumb and aligned. Level baseplates true to plane, with full bearing on concrete bases.
- C. Fasten kennel equipment securely to substrates with anchorage indicated.
- D. Connect bathing equipment to plumbing systems.

3.3 ADJUSTING

- A. Adjust doors and operable hardware to operate smoothly, easily, properly, and without binding. Confirm that locks engage accurately and securely without forcing or binding.
- B. After completing installation, inspect exposed finishes and repair damaged finishes.

END OF SECTION 1131900

SECTION 134717 - BULLET RESISTANT STOREFRONT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Bullet Resistant Storefront System.
- B. Bullet Resistant Doors.

1.2 REFERENCES

- A. ASTM International (ASTM):
 1. ASTM A36/A36 M - Standard Specification for Carbon Structural Steel.
 2. ASTM A924/A924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 4. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 5. ASTM C509 - Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
 6. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
 7. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
 8. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass.
 9. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.
 10. ASTM E1986 - Standard Test method for performance of exterior windows, curtain walls, doors and storm shutters impacted by missiles and exposed to cyclic pressure differentials.
- B. Aluminum Association Standard AA DAF-45 - Designation System for Aluminum Finishes.
- C. GANA - Glass Association of North America - Glazing Manual.
- D. NIJ Standard 0108.01 - (National Institute of Justice) Standard for Ballistic Resistant Protective Materials (September, 1985).
- E. UL 752 - Standard for Bullet Resisting Equipment (January 27, 1995)
- F. GSA TS01 - US General Services Administration Standard Test Method for Glazing and Window Systems Subject to Dynamic Overpressure Loadings; 2003.
- G. DOD UFC 4-010-01 - United Facilities Criteria (UFC) DOD Minimum Antiterrorism Standards for Buildings.

1.3 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings:
 - 1. Submit shop drawings prepared by the manufacturer showing plans, sections, elevations, layouts, profiles and product component locations, including anchorage, bracing, fasteners, accessories and finishes.
 - 2. Include dimensioned elevation of each type opening assembly in project; indicate sizes and locations of hardware, and lites if specified.
 - 3. Schedule: Indicate each opening assembly in project; cross-referenced to plans, elevations, and details.
- D. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.
- E. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified with a minimum documented experience of five years.
- B. Installer Qualifications: Company specializing in installation of products specified with minimum three years documented experience.
- C. Pre-installation Meetings: Conduct pre-installation meeting to verify project requirements, substrate conditions, and manufacturer's installation instructions.
- D. Coordination of Work: Coordinate layout and installation of components with other construction.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's unopened, undamaged packaging, with manufacturer's labels intact.
- B. Remove wraps or covers from windows and frames upon delivery at the building site; clean and touch-up scratches or disfigurement caused by shipping or handling promptly.
- C. Store assemblies covered to protect them from damage but permitting air circulation.

1.6 SEQUENCING

- A. Ensure that locating templates and other information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress.
- B. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.7 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Total Security Solutions

2.2 COMPONENTS

- A. Extruded Aluminum: ASTM B221; 6061 alloy, T5 temper typical, 6061 alloy, T6 temper for extruded structural members.
- B. Sheet Aluminum: ASTM B209, 5005 alloy, H15 or H34 temper.
- C. Sheet Steel: ASTM A924/A924M; galvanized to minimum G90.
- D. Steel Sections: ASTM A36/A36M; shaped to suit mullion sections, galvanized.
- E. Internal framing fasteners Type Zinc Coated.
- F. Neoprene Glazing Gaskets:
 - 1. Interior Glazing gaskets closed cell cellular neoprene conforming to ASTM C 509 Type II Option 1 with a 40-50 Shore A Durometer.
 - 2. Exterior Glazing gaskets solid neoprene conforming to ASTM C 864 with a 65-75 Shore A Durometer.
- G. Weatherstripping: Entrance manufacturer's standard types to suit application.
- H. Fasteners: Stainless steel or corrosion resistant steel.

2.3 BULLET RESISTANT STOREFRONT SYSTEMS

- A. Bullet Resistant Fixed Sash System: Head and sill are one piece extrusions with no integral weep system at the sill. Jambs are two piece extrusion with removable faces to allow for reglazing. Mullions are three piece extrusion with removable faces to allow for glazing and individual lite replacement. All joints and connections shall be tight, providing hairline joints and true alignment of adjacent members. Glazing must not be removable from the threat side of the sash. Provide to dimension heights and widths indicated on the Drawings.
 - 1. System shall be designed to defeat ballistic assaults in accordance with UL 752, Level 4-8.
 - 2. Aluminum Frames:
 - a. Head, Sill and Jamb Size: 1-1/2 inches by 5 1/2 inches.
 - b. Mullion Size: 3 inches by 5 1/2 inches.
 - 3. Glazing:
 - a. Glazing to conform to UL 752 of the following protection level.
 - 1) Level 5
- B. Bullet Resistant Door System: All joints and connections shall be tight, providing hairline joints and true alignment of adjacent members. Corner joinery shall consist of heavy duty extruded and keyed aluminum corner splines with continuous 3/8 inch diameter tie rod construction. Glazing must not be removable from the threat side of the door. Provide to

dimension heights and widths indicated on the Drawings.

1. System shall be designed to defeat ballistic assaults from a 44 magnum handgun in accordance with UL 752, Level 3.
2. Aluminum Doors:
 - a. Top rail and stile 2-3/4 inches (70 mm).
 - b. Bottom rail 8-1/2 inches (216 mm) including glass stops.
3. Aluminum Door and Sidelight Frames and Extrusions:
 - a. Size 1 3/4 inches (44 mm) by 4 inches (102 mm).
 - b. Structural sections shall be .125 inches thickness.
4. Door Hardware:
 - a. SELECT SL-11HD continuous aluminum gear hinge.
 - b. Adams Rite MS1850 deadlock with Adams Rite 4510 Series mortise thumb turn and or Keyed mortise cylinder.
 - c. 9 inch aluminum pull handle as selected by the Architect.
 - d. Door width aluminum push bar as selected by the Architect.
 - e. LCN 4000 series heavy duty door closer.

2.4 FACTORY FINISH

- A. Provide aluminum finishes in accordance with Aluminum Association Standard AA DAF-45.
- B. Clear Anodized Aluminum Surfaces: 204-R1 Class-II anodized aluminum coating.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install plumb, level, square, true to line, and without warp or rack.
- C. Provide all fasteners required for installation.
- D. Anchor frames securely in place to supports. Use attachment methods permitting adjustment for construction tolerances, irregularities, alignment, and expansion and contraction.
- E. Separate aluminum from other metal surfaces with bituminous coatings or other means approved by Architect.

- F. Sheet Metal Flashing: Coordinate with sheet metal flashing as specified in Section 07 62 00 - Sheet Metal Flashing and Trim.
- G. Joint Sealants: Install joint sealants as specified in Section 07 91 26 - Joint Fillers.
- H. Adjust door equipment for correct function and smooth operation.
- I. Verify water and weather tight installation.
- J. Remove temporary protection.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's representative to verify that installation is in conformance to the manufacturer's recommendations.

3.5 CLEANING

- A. Clean interior and exterior glass surfaces promptly after installation in accordance with manufacturer's instructions.
- B. Remove excess joint sealant in accordance with sealant manufacturer's instructions.
- C. Do not use harsh cleaning materials or methods that would damage glazing or finish.

3.6 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 142400 - HYDRAULIC ELEVATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydraulic passenger elevators.

B. Related Requirements:

1. Section 042000 "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry and for grouting elevator entrance frames installed in masonry walls.
2. Section 055000 "Metal Fabrications" for the following:
 - a. Attachment plates and angle brackets for supporting guide-rail brackets.
 - b. Hoist beams.
 - c. Structural-steel shapes for subsills.
 - d. Pit ladders.
3. **<Insert Section number and title>** for finish flooring in elevator cars.
4. Section 099123 "Interior Painting" for field painting of hoistway entrance doors and frames.
5. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair conductors used for telephone service for elevators.
6. Section 284621.11 "Addressable Fire-Alarm Systems" for smoke detectors in elevator lobbies to initiate emergency recall operation and heat detectors in shafts and machine rooms to disconnect power from elevator equipment before sprinkler activation and for connection to elevator controllers.

1.2 DEFINITIONS

- A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.
- B. Service Elevator: A passenger elevator that is also used to carry freight.

1.3 ACTION SUBMITTALS

- A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures; hoistway entrances; and operation, control, and signal systems.
- B. Shop Drawings:

1. Include plans, elevations, sections, and large-scale details indicating service at each landing; machine room layout; coordination with building structure; relationships with other construction; and locations of equipment.
2. Include large-scale layout of car-control station[**and standby-power operation control panel**].
3. Indicate maximum dynamic and static loads imposed on building structure at points of support as well as maximum and average power demands.

C. Samples for Initial Selection: For finishes involving color selection.

D. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes, **3-inch- (75-mm-)** square Samples of sheet materials and **4-inch (100-mm)** lengths of running trim members.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Manufacturer Certificates: Signed by elevator manufacturer, certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service including standby-power generator, as shown and specified, are adequate for elevator system being provided.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.

1. Submit manufacturer's/installer's standard operation and maintenance manual, in accordance with ASME A17.1/CSA B44 including diagnostic and repair information available to manufacturer's and Installer's maintenance personnel.

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner with terms, conditions, and obligations as set forth in, and in same form as, "Draft of Elevator Maintenance Agreement" at end of this Section, starting on date initial maintenance service is concluded.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Elevator manufacturer or an authorized representative who is trained and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials, components and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.8 COORDINATION

- A. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
- B. Furnish well casing and coordinate delivery with related excavation work.
- C. Coordinate locations and dimensions of other work specified in other Sections that relates to hydraulic elevators, including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.9 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
 - 2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Delaware Elevator.
 - 2. Fujitec America, Inc.
 - 3. KONE Inc.
 - 4. Otis Worldwide Corporation.
 - 5. Schindler Elevator Corp.
- B. Source Limitations: Obtain elevators from single manufacturer.

1. Major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cars, and entrances, are manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.
- B. Accessibility Standard: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and ICC A117.1.

2.3 ELEVATORS

- A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturers' standard components are used, as included in standard elevator systems and as required for complete system.
- B. Elevator Description:
 - a. Under-the-car single cylinder.
 2. Rated Load: 4500 lb (2043 kg).
 3. Rated Speed: 75 or 80 fpm (0.38 or 0.41 m/s).
 4. Operation System: Single automatic operation.
 5. Auxiliary Operations:
 - a. Standby-power operation.
 - b. Standby-powered lowering.
 - c. Automatic operation of lights and ventilation fans.
 6. Security Features: Card-reader operation.
 7. Car Enclosures:
 - a. Inside Width: Not less than 72 inches from side wall to side wall.
 - b. Inside Depth: Not less than 105 inches from back wall to front wall (return panels).
 - c. Inside Height: Not less than 93 inches (2362 mm) to underside of ceiling.
 - d. Front Walls (Return Panels): Satin stainless steel, ASTM A480/A480M, No. 4 finish with integral car door frames.
 - e. Car Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
 - f. Side and Rear Wall Panels: Enameled or powder-coated steel .
 - g. Reveals: Black.
 - h. Door Faces (Interior): Satin stainless steel, ASTM A480/A480M, No. 4 finish.
 - i. Door Sills: Aluminum.
 - j. Ceiling: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
 - k. Handrails: 1-1/2 inches (38 mm) round satin stainless steel, at sides and rear of car.

1. Floor prepared to receive resilient flooring (specified in Section 096500 "Resilient Flooring").
8. Hoistway Entrances:
 - a. Width: 36 inches (914 mm).
 - b. Height: 84 inches (2134 mm).
 - c. Type: Single-speed side sliding.
 - d. Frames: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
 - e. Doors: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
 - f. Sills: Aluminum.
9. Hall Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
10. Additional Requirements:
 - a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, ASTM A480/A480M, No. 4 finish.
 - b. Provide hooks for protective pads and one complete set(s) of full-height protective pads.

2.4 SYSTEMS AND COMPONENTS

- A. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations.
 1. Pump is submersible type with submersible squirrel-cage induction motor, and shall be suspended inside oil tank from vibration isolation mounts or is tank-top-mounted type with fan-cooled, squirrel-cage induction motor, and is mounted on oil tank with vibration isolation mounts and enclosed in prime-painted steel enclosure lined with 1-inch- (25-mm-) thick, glass-fiber insulation board.
 2. Motor has variable-voltage, variable-frequency control.
- B. Hydraulic Silencers: System has hydraulic silencer containing pulsation-absorbing material in blowout-proof housing at pump unit.
- C. Piping: Size, type, and weight of piping as recommended by elevator manufacturer, with flexible connectors to minimize sound and vibration transmissions from power unit.
 1. Cylinder units are connected with dielectric couplings.
 2. Casing for Underground Piping: Schedule 40 PVC pipe complying with ASTM D1785, joined with PVC fittings complying with ASTM D2466 and solvent cement complying with ASTM D2564.
- D. Hydraulic Fluid: Elevator manufacturer's standard [**fire-resistant**] fluid with additives as needed to prevent oxidation of fluid, corrosion of cylinder and other components, and other adverse effects.

- E. Hydraulic Fluid: Nontoxic, biodegradable, fire-resistant fluid, made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives, that is approved by elevator manufacturer for use with elevator equipment.
- F. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.
- G. Protective Cylinder Casing: PVC or HDPE pipe casing complying with ASME A17.1/CSA B44, of sufficient size to provide not less than **1-inch (25-mm)** clearance from cylinder and extending above pit floor. Casing has means of monitoring effectiveness to comply with ASME A17.1/CSA B44.
- H. Corrosion-Protective Filler: A nontoxic, petroleum-based gel formulated for filling the space between hydraulic cylinder and protective casing. Filler is electrically nonconductive, displaces or absorbs water, and gels or solidifies at temperatures below **60 deg F (16 deg C)**.
- I. Car Frame and Platform: Welded or bolted steel units.
- J. Guides: Roller guides. Provide guides at top and bottom of car frame.

2.5 OPERATION SYSTEMS

- A. Provide manufacturer's standard microprocessor operation system as required to provide type of operation indicated.
- B. Auxiliary Operations:
 - 1. Single-Car Standby-Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at main lobby. Manual operation causes automatic operation to cease.
 - 2. Single-Car Standby-Powered Lowering:
 - a. On activation of standby power, if car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to a preselected floor, opens its doors, and shuts down. If car is below the preselected floor, it is lowered to the next lower floor, opens its doors, and shuts down.
 - b. On activation of standby power, car is lowered to the lowest floor, opens its doors, and shuts down.
 - 3. Automatic Operation of Lights and Fan: When elevator is stopped and unoccupied with doors closed, lighting, ventilation fan, and cab displays are de-energized after 5 minutes and are re-energized before car doors open.
- C. Security Features: Security features do not affect emergency firefighters' service.
 - 1. Card-Reader Operation: System uses card readers at car-control stations and hall push-button stations to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling

cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. Allow space for card reader in car.

- a. Security access system equipment is specified in Section 281500 "Access Control Hardware Devices."

2.6 DOOR-REOPENING DEVICES

- A. Infrared Array: Provide door-reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams causes doors to stop and reopen.

2.7 CAR ENCLOSURES

- A. Provide enameled- or powder-coated-steel car enclosures to receive removable steel-framed car enclosures with nonremovable wall panels, with removable car roof, access doors, power door operators, and ventilation.

1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.

- B. Materials and Finishes: Manufacturer's standards, but not less than the following:

1. Subfloor:

- a. Exterior, C-C Plugged grade plywood, not less than **7/8-inch (22.2-mm)** nominal thickness.

2. Floor Finish:

- a. Specified in **<Insert Section number> "<Insert Section title>."**

3. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to manufacturer's standard honeycomb core with manufacturer's standard protective edge trim. Panels have a flame-spread index of 25 or less, when tested according to ASTM E84. Plastic-laminate color, texture, and pattern as selected by Architect from plastic-laminate manufacturer's full range.
4. Fabricate car with recesses and cutouts for signal equipment.
5. Fabricate car door frame integrally with front wall of car.
6. Stainless Steel Doors: Flush, hollow-metal construction; fabricated from stainless steel sheet or by laminating stainless steel sheet to exposed faces and edges of enameled- or powder-coated-steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
7. Sight Guards: Provide sight guards on car doors.
8. Sills: Extruded or machined metal, with grooved surface, **1/4 inch (6.4 mm)** thick.
9. Metal Ceiling: Flush panels, with LED downlights in each panel. Align ceiling panel joints with joints between wall panels.
10. Light Fixture Efficiency: Not less than 35 lumens/W.
11. Ventilation Fan Efficiency: Not less than **3.0 cfm/W (1.4 L/s per W)**.

2.8 HOISTWAY ENTRANCES

- A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile accommodate hoistway wall construction.
 - 1. Where gypsum board wall construction is indicated, frames are self-supporting with reinforced head sections.
- B. Fire-Rated Hoistway Entrance Assemblies: Door-and-frame assemblies comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to [NFPA 252] [or] [UL 10B].
 - 1. Fire-Protection Rating: 1 hour.
- C. Materials and Fabrication: Manufacturer's standards, but not less than the following:
 - 1. Stainless Steel Frames: Formed from stainless steel sheet.
 - 2. Star of Life Symbol: Identify emergency elevators with star of life symbol, not less than 3 inches (76 mm) high, on both jambs of hoistway door frames.
 - 3. Stainless Steel Doors: Flush, hollow-metal construction; fabricated from stainless steel sheet or by laminating stainless steel sheet to exposed faces and edges of enameled- or powder-coated-steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
 - 4. Sight Guards: Provide sight guards on doors matching door edges.
 - 5. Sills: Extruded or machined metal, with grooved surface, 1/4 inch (6.4 mm) thick.
 - 6. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

2.9 SIGNAL EQUIPMENT

- A. Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Provide buttons and lighted elements illuminated with LEDs.
- B. Car-Control Stations: Provide manufacturer's standard recessed car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.
 - 1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
 - 2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
- C. Swing-Return Car-Control Stations: Provide car-control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.
 - 1. Mark buttons and switches for function. Use both tactile symbols and Braille.

2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
- D. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.
 - E. Firefighters' Two-Way Telephone Communication Service: Provide telephone jack in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Section 284621.11 "Addressable Fire-Alarm Systems."
 - F. Car Position Indicator: Provide illuminated, digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.
 - G. Hall Push-Button Stations: Provide one hall push-button station at each landing.
 1. Provide units with flat faceplate for mounting with body of unit recessed in wall.
 2. Equip units with buttons for calling elevator and for indicating applicable direction of travel.
 - H. Hall Lanterns: Units with illuminated arrows; however, provide single arrow at terminal landings. Provide the following:
 1. Manufacturer's standard wall-mounted units, for mounting above entrance frames.
 - I. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
 1. At manufacturer's option, audible signals may be placed on cars.
 - J. Hall Position Indicators: Providedigital-display-type position indicators, located above hoistway entrance at ground floor.
 1. Provide units with flat faceplate for mounting and with body of unit recessed in wall.
 2. Integrate ground-floor hall lanterns with hall position indicators.
 - K. Standby-Power Elevator Selector Switches: Provide switches, as required by ASME A17.1/CSA B44, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed.
 - L. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.

2.10 FINISH MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, commercial steel, Type B, exposed, matte finish.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, commercial steel, Type B, pickled.
- C. Stainless Steel Sheet: ASTM A240/A240M, Type 304.
- D. Stainless Steel Bars: ASTM A276, Type 304.
- E. Stainless Steel Tubing: ASTM A554, Grade MT 304.
- F. Aluminum Extrusions: **ASTM B221** (**ASTM B221M**), Alloy 6063.
- G. Plastic Laminate: High-pressure type complying with NEMA LD 3, Type HGS for flat applications Type BKV for panel backing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Excavation for Cylinder: Drill well hole in elevator pit to accommodate installation of cylinder; comply with applicable requirements in Section 312000 "Earth Moving."
- B. Provide waterproof well casing to retain well-hole walls.
- C. Install cylinder in protective casing within well hole. Before installing protective casing, remove water and debris from well hole and provide permanent waterproof seal at bottom of well casing.
 - 1. Fill void space between protective casing and cylinder with corrosion-protective filler.
 - 2. Align cylinder and fill space around protective casing with fine sand.

- D. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor. Seal between [well] [protective] casing and pit floor with 4 inches (100 mm) of nonshrink, nonmetallic grout.
- E. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS workmanship and welding operator qualification standards.
- F. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.
- G. Install piping above the floor, where possible. Install underground piping in casing.
 - 1. Excavate for piping and backfill encased piping according to applicable requirements in Section 312000 "Earth Moving."
- H. Lubricate operating parts of systems as recommended by manufacturers.
- I. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
- J. Leveling Tolerance: 1/4 inch (6 mm), up or down, regardless of load and travel direction.
- K. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
- L. Locate hall signal equipment for elevators as follows unless otherwise indicated:
 - 1. Mount hall lanterns at a minimum of 72 inches (1829 mm) above finished floor.

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.
- B. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.

3.4 PROTECTION

- A. Temporary Use: Comply with the following requirements for elevator used for construction purposes:
 - 1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.

2. Provide strippable protective film on entrance and car doors and frames.
3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
5. Do not load elevators beyond their rated weight capacity.
6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).
- B. Check operation of elevator with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

3.6 MAINTENANCE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service includes 12 months' full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation. Parts and supplies are manufacturer's authorized replacement parts and supplies.
 1. Perform maintenance during normal working hours.
 2. Perform emergency callback service during normal working hours with response time of two hours or less.

END OF SECTION 142400

SECTION 210517 SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.
 - 6. Silicone sealants.

1.2 ACTION SUBMITTALS

- A. Product Data for each type of product.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.
- B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, anticorrosion coated, with plain ends and integral welded waterstop collar.
- C. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

- A. Description: Manufactured, Dura-coated or Duco-coated galvanized cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: Carbon steel or Composite plastic.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B 633 or Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.
- B. Plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. Description: Non-shrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.6 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, Use NT.
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3 EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Use silicone sealant to seal around the outside of stack-sleeve fittings.

- B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- or smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Use grout or silicone sealant, to seal the space around outside of sleeve-seal fittings.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Concrete Slabs above Grade: Piping Smaller Than NPS 6: Steel pipe sleeves.
 - 2. Interior Partitions: Piping Smaller Than NPS 6: Steel Pipe Sleeves

END OF SECTION

SECTION 210518 ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.2 DEFINITIONS

- A. Existing Piping to Remain:** Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

- A. Product Data** for each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Steel Type:** With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Stainless-Steel Type:** With polished stainless-steel finish.
- C. One-Piece, Cast-Brass Type:** With polished, chrome-plated finish and setscrew fastener.
- D. One-Piece, Deep-Pattern Type:** Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
- E. One-Piece, Stamped-Steel Type:** With polished, chrome-plated finish and spring-clip fasteners.
- F. Split-Plate, Stamped-Steel Type:** With polished, chrome-plated finish; concealed and exposed-rivet hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

- A. Split Floor Plates:** Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Chrome-Plated Piping: One-piece steel or split-plate steel with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
 - f. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
 - g. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - h. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
 - i. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
 - j. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
 - 2. Escutcheons for Existing Piping to Remain:
 - a. Chrome-Plated Piping: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - c. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - d. Bare Piping in Unfinished Service Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - e. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.

- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor plate.
 - 2. Existing Piping: Split floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION

SECTION 210523 GENERAL-DUTY VALVES FOR FIRE PROTECTION PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Two-piece ball valves with indicators.
 2. Bronze butterfly valves with indicators.
 3. Iron butterfly valves with indicators.
 4. Check valves.
 5. Bronze OS&Y gate valves.
 6. Iron OS&Y gate valves.
 7. NRS gate valves.
 8. Trim and drain valves.

1.2 DEFINITIONS

- A. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- B. NRS: Non-rising stem.
- C. OS&Y: Outside screw and yoke.
- D. SBR: Styrene-butadiene rubber.

1.3 ACTION SUBMITTALS

- A. Product Data for each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, and weld ends.
 3. Set valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

GENERAL DUTY VALVES FOR FIRE PROTECTION PIPING

- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.
- D. Protect flanges and specialties from moisture and dirt.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:
 - 1. Main Level: HAMV - Fire Main Equipment.
 - a. Level 1: HCBZ - Indicator Posts, Gate Valve.
 - b. Level 1: HLOT - Valves.
 - 1) Level 3: HLUG - Ball Valves, System Control.
 - 2) Level 3: HLXS - Butterfly Valves.
 - 3) Level 3: HMER - Check Valves.
 - 4) Level 3: HMRZ - Gate Valves.
 - 2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.
 - 3. Level 1: VQGU - Valves, Trim and Drain.
- B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:
 - 1. Automated Sprinkler Systems:
 - a. Indicator posts.
 - b. Valves.
 - 1) Gate valves.
 - 2) Single check valves.
 - 3) Miscellaneous valves.
- C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.
- D. ASME Compliance:
 - 1. ASME B16.1 for flanges on iron valves.
 - 2. ASME B1.20.1 for threads for threaded-end valves.
 - 3. ASME B31.9 for building services piping valves.
- E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- F. NFPA Compliance: Comply with NFPA 24 for valves.

- G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.
- H. Valve Sizes: Same as upstream piping unless otherwise indicated.
- I. Valve Actuator Types:
 - 1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
 - 2. Handwheel: For other than quarter-turn trim and drain valves.
 - 3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.2 TWO-PIECE BALL VALVES WITH INDICATORS

A. Description:

- 1. UL 1091, except with ball instead of disc and FM Global standard for indicating valves (butterfly or ball type), Class Number 1112.
- 2. Minimum Pressure Rating: 175 psig.
- 3. Body Design: Two piece.
- 4. Body Material: Forged brass or bronze.
- 5. Port Size: Full or standard.
- 6. Seats: PTFE.
- 7. Stem: Bronze or stainless steel.
- 8. Ball: Chrome-plated brass.
- 9. Actuator: Worm gear or traveling nut.
- 10. Supervisory Switch: Internal or external.
- 11. End Connections for Valves NPS 1 through NPS 2: Threaded ends.
- 12. End Connections for Valves NPS 2-1/2: Grooved ends.

2.3 BRONZE BUTTERFLY VALVES WITH INDICATORS

A. Description:

- 1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 1112.
- 2. Minimum: Pressure rating: 175 psig.
- 3. Body Material: Bronze.
- 4. Seat Material: EPDM.
- 5. Stem Material: Bronze or stainless steel.
- 6. Disc: Bronze.
- 7. Actuator: Worm gear or traveling nut.
- 8. Supervisory Switch: Internal or external.
- 9. End Connections for Valves NPS 1 through NPS 2: Threaded ends.
- 10. End Connections for Valves NPS 2-1/2: Grooved ends.

2.4 IRON BUTTERFLY VALVES WITH INDICATORS

A. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated.
7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Body Design: Lug or wafer.

2.5 CHECK VALVES

A. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.6 BRONZE OS&Y GATE VALVES

A. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Bronze or brass.
4. Wedge: One-piece bronze or brass.
5. Wedge Seat: Bronze.
6. Stem: Bronze or brass.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Threaded.

2.7 IRON OS&Y GATE VALVES

A. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged Grooved Threaded.

2.8 NRS GATE VALVES

A. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged or Threaded.

2.9 TRIM AND DRAIN VALVES

A. Ball Valves:

1. Description:
 - a. Pressure Rating: 175 psig.
 - b. Body Design: Two piece.
 - c. Body Material: Forged brass or bronze.
 - d. Port size: Full or standard.
 - e. Seats: PTFE.
 - f. Stem: Bronze or stainless steel.
 - g. Ball: Chrome-plated brass.
 - h. Actuator: Handlever.
 - i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
 - j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

B. Angle Valves:

1. Description:

- a. Pressure Rating: 175 psig.
- b. Body Material: Brass or bronze.
- c. Ends: Threaded.
- d. Stem: Bronze.
- e. Disc: Bronze.
- f. Packing: Asbestos free.
- g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:

1. Description:

- a. Pressure Rating: 175 psig.
- b. Body Material: Bronze with integral seat and screw-in bonnet.
- c. Ends: Threaded.
- d. Stem: Bronze.
- e. Disc Holder and Nut: Bronze.
- f. Disc Seat: Nitrile.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

- A. Comply with requirements in the following Sections for specific valve installation requirements and applications:

GENERAL DUTY VALVES FOR FIRE PROTECTION PIPING

1. Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.
 - B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
 - C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
 - D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.
 - E. Install valves in horizontal piping with stem at or above the pipe center.
 - F. Install valves in position to allow full stem movement.
 - G. Install valve tags. Comply with requirements in Section 210553 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.
 - H. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections.
 - I. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

END OF SECTION

**SECTION 210553 IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND
EQUIPMENT**

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.
- D. Valve Schedules: Valve numbering scheme.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032 inch thick, with predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

6. Fasteners: Stainless-steel rivets.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment-Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for

greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction according to ASME A13.1.
- B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: Size letters according to ASME A13.1 for piping.
- E. Pipe-Label Colors:
 - 1. Background Color: Safety Red.
 - 2. Letter Color: White.

2.4 STENCILS

- A. Stencils for Piping:
 - 1. Lettering Size: Size letters according to ASME A13.1 for piping.
 - 2. Stencil Material: Aluminum.
 - 3. Stencil Paint: Safety Red, exterior, gloss, Paint may be in pressurized spray-can form.
 - 4. Identification Paint: White, exterior, Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

- A. Description: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.
 - 2. Fasteners: Brass wire-link chain or S-hook.
 - 3. Valve-Tag Color: Safety Red.
 - 4. Letter Color: White.

- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Description: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5-1/4 inches minimum.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Safety Yellow background with black lettering.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surface of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Piping: Painting of piping is specified in Section 099123 "Interior Painting."
- B. Stenciled Pipe-Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit a view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes including pipes where flow is allowed in both directions.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
 - 1. Valve-Tag Size and Shape:
 - a. Fire-Suppression Standpipe: 2 inches, square.

- b. Wet-Pipe Sprinkler System: 1-1/2 inches, round.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 211119 FIRE DEPARTMENT CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes Flush-type fire-department connections.

1.2 ACTION SUBMITTALS

- A. Product Data for each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each fire-department connection.

PART 2 PRODUCTS

2.1 FLUSH TYPE FIRE DEPARTMENT CONNECTION

- A. Standard: UL 405.
- B. Type: Flush, for wall mounting.
- C. Pressure Rating: 175 psig minimum.
- D. Body Material: Corrosion-resistant metal.
- E. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
- F. Caps: Brass, lugged type, with gasket and chain.
- G. Escutcheon Plate: Rectangular, brass, wall type.
- H. Outlet: With pipe threads.
- I. Body Style: Horizontal.
- J. Number of Inlets: Four.
- K. Outlet Location: Back.
- L. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
- M. Finish: Polished chrome plated.

- N. Outlet Size: NPS 6.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.
- B. Examine roughing-in for fire-suppression standpipe system to verify actual locations of piping connections before fire-department connection installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-type fire-department connections.
- B. Install automatic ball-drip drain valve at each check valve for fire-department connection.

END OF SECTION

SECTION 211313 WET-PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Cover system for sprinkler piping.
 - 3. Specialty valves.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Manual control stations.
 - 7. Control panels.
 - 8. Pressure gauges.
- B. Related Requirements: Section 211119 "Fire Department Connections" for exposed, flush, and yard type fire department connections.

1.2 DEFINITIONS

- A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig, but not higher than 250 psig.
- B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Sustainable Design Submittals
- C. Shop Drawings for Wet-Pipe Sprinkler Systems.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.
- D. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Domestic water piping.
 - 2. Compressed air piping.
 - 3. HVAC hydronic piping.
 - 4. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
- B. Qualification Data: For qualified Installer and professional engineer.
- C. Design Data: Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- D. Welding certificates.
- E. Field Test Reports:
 - 1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
 - 2. Fire-hydrant flow test report.
- F. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

1.8 FIELD CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify Architect Construction Manager Owner no fewer than two days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without Architect's Construction Manager's Owner's written permission.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13.
- B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- C. High-Pressure Piping System Component: Listed for 250-psig minimum working pressure.
- D. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.
 1. Available fire-hydrant flow test records indicate the following conditions:
 - a. Date
 - b. Time
 - c. Performed by
 - d. Location of Residual Fire Hydrant R

- e. Location of Flow Fire Hydrant F
 - f. Static Pressure at Residual Fire Hydrant R
 - g. Measured Flow at Flow Fire Hydrant F
 - h. Residual Pressure at Residual Fire Hydrant R
2. Sprinkler system design shall be approved by authorities having jurisdiction.
 - a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - b. Sprinkler Occupancy Hazard Classifications:
 - 1) Automobile Parking Areas: Ordinary Hazard, Group 1.
 - 2) Building Service Areas: Ordinary Hazard, Group 1.
 - 3) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - 4) General Storage Areas: Ordinary Hazard, Group 1.
 - 5) Libraries except Stack Areas: Light Hazard.
 - 6) Library Stack Areas: Ordinary Hazard, Group 2.
 - 7) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - 8) Office and Public Areas: Light Hazard.
 - 9) Plastics Processing Areas: Extra Hazard, Group 2.
 3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
 - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
 - d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
 - e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
 - f. Special Occupancy Hazard: As determined by authorities having jurisdiction.
 4. Minimum Density for Deluge-Sprinkler Piping Design:
 - a. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over entire area.
 - b. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over entire area.
 - c. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over entire area.
 - d. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over entire area.
 - e. Special Occupancy Hazard: As determined by authorities having jurisdiction.
 5. Maximum Protection Area per Sprinkler: According to UL listing.
 6. Maximum Protection Area per Sprinkler:
 - a. Office Spaces: 225 sq. ft.
 - b. Storage Areas: 130 sq. ft.
 - c. Mechanical Equipment Rooms: 130 sq. ft.
 - d. Electrical Equipment Rooms: 130 sq. ft.
 - e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
- E. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

2.2 STEEL PIPE AND FITTINGS

- A. Standard-Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E,. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 30, Black-Steel Pipe: ASTM A 135/A 135M; ASTM A 795/A 795M, Type E; or ASME B36.10M wrought steel, with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
- C. Malleable- or Ductile-Iron Unions: UL 860.
- D. Cast-Iron Flanges: ASME 16.1, Class 125.
- E. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
 - 1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick.
 - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
 - 2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.
- F. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
 - 1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Pressure Rating: 175-psig minimum.
 - 2. Galvanized Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
 - 3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
- H. Steel Pressure-Seal Fittings: UL 213, FM Global-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

2.3 COVER SYSTEM FOR SPRINKLER PIPING

- A. Description: System of support brackets and covers made to protect sprinkler piping.
- B. Brackets: Glass-reinforced nylon.

- C. Covers: Extruded-PVC sections of length, shape, and size required for size and routing of CPVC piping.

2.4 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global "Approval Guide."
- B. Pressure Rating
 - 1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.
 - 2. High-Pressure Piping Specialty Valves: 250-psig minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Alarm Valves:
 - 1. Standard: UL 193.
 - 2. Design: For horizontal or vertical installation.
 - 3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
 - 4. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
 - 5. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
 - 6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Automatic (Ball Drip) Drain Valves:
 - 1. Standard: UL 1726.
 - 2. Pressure Rating: 175-psig minimum.
 - 3. Type: Automatic draining, ball check.
 - 4. Size: NPS 3/4.
 - 5. End Connections: Threaded.

2.5 SPRINKLER PIPING SPECIALTIES

- A. Branch Outlet Fittings:
 - 1. Standard: UL 213.
 - 2. Pressure Rating: 175-psig minimum.
 - 3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
 - 4. Type: Mechanical-tee and -cross fittings.

5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global "Approval Guide."
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175 psig.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global "Approval Guide."
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

1. Standard: UL 1474.
2. Pressure Rating: 250-psig minimum.
3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

F. Flexible Sprinkler Hose Fittings:

1. Standard: UL 1474.

2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
3. Pressure Rating: 175-psig minimum.
4. Size: Same as connected piping, for sprinkler.

2.6 SPRINKLERS

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global "Approval Guide."
- B. Pressure Rating for Residential Sprinklers: 175-psig maximum.
- C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- D. Pressure Rating for High-Pressure Automatic Sprinklers: 250-psig minimum.
- E. Automatic Sprinklers with Heat-Responsive Element:
 1. Early-Suppression, Fast-Response Applications: UL 1767.
 2. Nonresidential Applications: UL 199.
 3. Residential Applications: UL 1626.
 4. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- F. Sprinkler Finishes: Baked on enamel finish
- G. Special Coatings: Wax.
- H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
 2. Sidewall Mounting: Chrome-plated steel, one piece, flat.
- I. Sprinkler Guards:
 1. Standard: UL 199.
 2. Type: Wire cage with fastening device for attaching to sprinkler.

2.7 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Electrically Operated Alarm Bell:

1. Standard: UL 464.
2. Type: Vibrating, metal alarm bell.
3. Size: 6-inch minimum diameter.
4. Finish: Red-enamel factory finish, suitable for outdoor use.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Water-Flow Indicators:

1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig.
6. Design Installation: Horizontal or vertical.

D. Pressure Switches:

1. Standard: UL 346.
2. Type: Electrically supervised water-flow switch with retard feature.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.8 MANUAL CONTROL STATIONS

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global "Approval Guide" for hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve.
- B. Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.9 CONTROL PANELS

- A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves.
 - 1. Listed in UL's "Fire Protection Equipment Directory" or FM Global "Approval Guide" when used with thermal detectors and Class A detector circuit wiring.
 - 2. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
 - 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- C. Manual Control Stations: Hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- D. Panels Components:
 - 1. Power supply.
 - 2. Battery charger.
 - 3. Standby batteries.
 - 4. Field-wiring terminal strip.
 - 5. Electrically supervised solenoid valves and polarized fire-alarm bell.
 - 6. Lamp test facility.
 - 7. Single-pole, double-throw auxiliary alarm contacts.
 - 8. Rectifier.

2.10 PRESSURE GAGES

- A. Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- C. Pressure Gage Range: 0- to 250-psig minimum.
- D. Label: Include "WATER" label on dial face.

PART 3 EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

- A. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.
- B. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.3 WATER-SUPPLY CONNECTIONS

- A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping.
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.4 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
 - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.

- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.
- N. Fill sprinkler system piping with water.
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.5 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
 - D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
 - F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
 - G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
 - I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
 - J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
 - K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
 - L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
 - M. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- 3.6 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING
- A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and NFPA 13 or NFPA 13R for supports.

3.7 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. Install valves in vertical position for proper direction of flow, in main supply to system.
 - 2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
 - 3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.8 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.9 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.10 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 4. Energize circuits to electrical equipment and devices.
 5. Coordinate with fire-alarm tests. Operate as required.
 6. Coordinate with fire-pump tests. Operate as required.
 7. Verify that equipment hose threads are same as local fire department equipment.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.11 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves and pressure-maintenance pumps.

3.13 PIPING SCHEDULE

- A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be the following:
 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

2. Standard weight black steel pipe with cut or roll grooved ends; uncoated grooved-end fittings for steel piping; grooved end pipe couplings for steel piping and grooved joints.

E. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be the following:

1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard weight or Schedule 30, black steel pipe with cut or roll grooved ends; uncoated grooved-end fittings for steel piping; grooved end pipe couplings for steel piping and grooved joints.
3. Standard weight or Schedule 30 black steel pipe with plain ends; steel welding fittings and welded joints.

3.14 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Pendent sprinklers semi-recessed sprinklers.
3. Wall Mounting: Sidewall sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Semi-recessed sprinkler: Baked on enamel finish with escutcheon. Match ceiling color.
2. Upright Pendent and Sidewall Sprinklers: Baked on enamel finish in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION

SECTION 220517 SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.2 ACTION SUBMITTALS

- A. Product Data for each type of product indicated.

PART 2 PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Jay R. Smith Mfg. Co.
 - 2. Zurn Industries, LLC.

- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. GPT; an EnPro Industries company.
 - 4. Metraflex Company (The).
 - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. GPT; an EnPro Industries company.
 - 4. Metraflex Company (The).
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves Galvanized-steel wall sleeves, Galvanized-steel-pipe sleeves, or Sleeve-seal fittings.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves.

2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system, Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system, Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system, Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves Stack-sleeve fittings.
 - b. Piping NPS 6 and Larger: Stack-sleeve fittings.
5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

SECTION 220518 ESCUTCHEONS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - g. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with rough-brass finish.
 - h. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with rough-brass finish.
 - 2. Escutcheons for Existing Piping:
 - a. Chrome-Plated Piping: Split-casting brass type with polished, chrome plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed or expose drivet hinge.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with rough brass finish.
 - f. Bare Piping in Equipment Rooms: Split-casting brass type with rough-brass finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

SECTION 220523 VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Bronze lift check valves.
4. Bronze swing check valves.
5. Iron swing check valves.
6. Iron swing check valves with closure control.
7. Iron, grooved-end swing check valves.
8. Iron, center-guided check valves.
9. Iron, plate-type check valves.
10. Bronze gate valves.
11. Iron gate valves.
12. Chainwheels

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Non-rising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.

1.3 ACTION SUBMITTALS

- A. Product Data for each type of valve. Certification that products comply with NSF 61 Annex G.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, grooves, weld ends, and soldered ends.
 3. Set ball valves open to minimize exposure of functional surfaces.
 4. Set check valves in either closed or open position.
 5. Set gate valves closed to prevent rattling.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
1. ASME B1.20.1 for threads for threaded end valves.
 2. ASME B16.1 for flanges on iron valves.
 3. ASME B16.5 for flanges on steel valves.
 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 5. ASME B16.18 for solder-joint connections.
 6. ASME B31.9 for building services piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. NSF Compliance: NSF 61 Annex G for valve materials for potable-water service.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.
- H. RS Valves in Insulated Piping: With 2-inch stem extensions.
- I. Valve Bypass and Drain Connections: MSS SP-45.

J. Valve Actuator Types: Handlever: For quarter-turn valves smaller than NPS 4.

K. Valves in Insulated Piping:

1. Include 2-inch stem extensions.
2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRASS BALL VALVES

A. Brass Ball Valves, One-Piece:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. KITZ Corporation.
2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig.
 - c. Body Design: One piece.
 - d. Body Material: Forged brass or bronze.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Brass or stainless steel.
 - h. Ball: Chrome-plated brass or stainless steel.
 - i. Port: Reduced.

B. Brass Ball Valves, Two-Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Valve, Inc.
 - b. Apollo Valves; Conbraco Industries, Inc.
 - c. KITZ Corporation.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.

- d. Body Material: Forged brass.
- e. Ends: Threaded and soldered.
- f. Seats: PTFE.
- g. Stem: Brass.
- h. Ball: Chrome-plated brass.
- i. Port: Full.

C. Brass Ball Valves, Three-Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Jomar Valve.
 - b. KITZ Corporation.
 - c. WATTS.
2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Three piece.
 - d. Body Material: Forged brass.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.

2.3 BRONZE BALL VALVES

A. Bronze Ball Valves, One-Piece with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. FNW; Ferguson Enterprises, Inc.
 - c. NIBCO INC.
 - d. WATTS.
2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig.
 - c. Body Design: One piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.

- g. Stem: Bronze.
- h. Ball: Chrome-plated brass.
- i. Port: Reduced.

B. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Bronze or brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.

C. Bronze Ball Valves, Three-Piece with Full Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. NIBCO INC.
 - c. WATTS.
2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Three piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Bronze or brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.

2.4 BRONZE LIFT CHECK VALVES

A. Bronze Lift Check Valves with Bronze Disc, Class 125:

1. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.

B. Bronze Lift Check Valves with Nonmetallic Disc, Class 125:

1. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: NBR, PTFE.

2.5 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 125:

1. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.

B. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:

1. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: PTFE.

C. Bronze Swing Check Valves with Bronze Disc, Class 150:

1. Description:
 - a. Standard: MSS SP-80, Type 3.

- b. CWP Rating: 300 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded or soldered. See valve schedule articles.
- f. Disc: Bronze.

D. Bronze Swing Check Valves with Nonmetallic Disc, Class 150:

- 1. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: PTFE.

2.6 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Metal Seats, Class 125:

- 1. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged or threaded. See valve schedule articles.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.

B. Iron Swing Check Valves with Nonmetallic-to-Metal Seats, Class 125:

- 1. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged or threaded. See valve schedule articles.
 - f. Trim: Composition.
 - g. Seat Ring: Bronze.
 - h. Disc Holder: Bronze.
 - i. Disc: PTFE.
 - j. Gasket: Asbestos free.

C. Iron Swing Check Valves with Metal Seats, Class 250:

- 1. Description:

- a. Standard: MSS SP-71, Type I.
- b. CWP Rating: 500 psig.
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged or threaded. See valve schedule articles.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.

2.7 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Iron Swing Check Valves with Lever- and Spring-Closure Control, Class 125:

- 1. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged or threaded. See valve schedule articles.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.
 - h. Closure Control: Factory-installed exterior lever and weight.

B. Iron Swing Check Valves with Lever and Weight-Closure Control, Class 125:

- 1. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged or threaded. See valve schedule articles.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.
 - h. Closure Control: Factory-installed exterior lever and weight.

2.8 IRON, GROOVED-END SWING CHECK VALVES

A. Iron, Grooved-End Swing Check Valves, 300 CWP:

- 1. Description:
 - a. CWP Rating: 300 psig.
 - b. Body Material: ASTM A 536, ductile iron.
 - c. Seal: EPDM.
 - d. Disc: Spring operated, ductile iron or stainless steel.

2.9 IRON, CENTER-GUIDED, SPRING-LOADED CHECK VALVES

A. Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat, Class 125:

1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Compact wafer, spring loaded.
 - e. Seat: Bronze.

B. Iron Globe, Center-Guided Check Valves with Metal Seat, Class 125:

1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: Bronze.

C. Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat, Class 150:

1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
 - d. Style: Compact wafer, spring loaded.
 - e. Seat: Bronze.

D. Iron Globe, Center-Guided Check Valves with Metal Seat, Class 150:

1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: Bronze.

E. Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat, Class 250:

1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 400 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Compact wafer, spring loaded.

- e. Seat: Bronze.
- F. Iron Globe, Center-Guided Check Valves with Metal Seat, Class 250:
- 1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 400 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: Bronze.
- G. Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat, Class 300:
- 1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 500 psig.
 - c. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
 - d. Style: Compact wafer, spring loaded.
 - e. Seat: Bronze.
- H. Iron Globe, Center-Guided Check Valves with Metal Seat, Class 300:
- 1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 500 psig.
 - c. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: Bronze.
- I. Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat, Class 125:
- 1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Compact wafer, spring loaded.
 - e. Seat: EPDM.
- J. Iron Globe, Center-Guided Check Valves with Resilient Seat, Class 125:
- 1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Globe, spring loaded.

- e. Ends: Flanged.
 - f. Seat: EPDM.
- K. Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat, Class 150:
- 1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
 - d. Style: Compact wafer, spring loaded.
 - e. Seat: EPDM.
- L. Iron, Globe, Center-Guided Check Valves with Resilient Seat, Class 150:
- 1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: EPDM.
- M. Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat, Class 250:
- 1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 400 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Compact wafer, spring loaded.
 - e. Seat: EPDM.
- N. Iron Globe, Center-Guided Check Valves with Resilient Seat, Class 250:
- 1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 400 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: EPDM.
- O. Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat, Class 300:
- 1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 500 psig.
 - c. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.

- d. Style: Compact wafer, spring loaded.
- e. Seat: EPDM.

P. Iron Globe, Center-Guided Check Valves with Resilient Seat, Class 300:

- 1. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 500 psig.
 - c. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: EPDM.

2.10 BRONZE GATE VALVES

A. Bronze Gate Valves, NRS, Class 125:

- 1. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: Bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

B. Bronze Gate Valves, RS, Class 125:

- 1. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: Bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

C. Bronze Gate Valves, NRS, Class 150:

- 1. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 300 psig.
 - c. Body Material: Bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.

- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

D. Bronze Gate Valves, RS, Class 150:

- 1. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: Bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

2.11 IRON GATE VALVES

A. Iron Gate Valves, NRS, Class 150:

- 1. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Material: Gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.
 - g. Packing and Gasket: Asbestos free.

B. Iron Gate Valves, OS&Y, Class 125:

- 1. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Material: Gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.
 - g. Packing and Gasket: Asbestos free.

C. Iron Gate Valves, NRS, Class 250:

- 1. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 500 psig.

- c. Body Material: Gray iron with bolted bonnet.
- d. Ends: Flanged.
- e. Trim: Bronze.
- f. Disc: Solid wedge.
- g. Packing and Gasket: Asbestos free.

D. Iron Gate Valves, OS&Y, Class 250:

- 1. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 500 psig.
 - c. Body Material: Gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.
 - g. Packing and Gasket: Asbestos free.

2.12 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.
 - 1. Sprocket Rim with Chain Guides: Ductile or cast iron of type and size required for valve. Include zinc or epoxy coating.
 - 2. Chain: Hot-dip galvanized steel, of size required to fit sprocket rim.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for gate valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.
- G. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Use gate valves for shutoff service only.
- C. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.
- D. If valve applications are not indicated, use the following:
 - 1. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; or iron, center-guided, metal-seat or resilient-seat check valves.

- c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

E. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; or iron, center-guided, metal-seat or resilient-seat check valves.
 - c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

F. End Connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded.
3. For Copper Tubing, NPS 5 and Larger: Flanged.
4. For Steel Piping, NPS 2 and Smaller: Threaded.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded.
6. For Steel Piping, NPS 5 and Larger: Flanged.
7. For Grooved-End Copper Tubing and Steel Piping: Grooved.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: Bronze swing check valves with bronze nonmetallic disc, Class 125 with soldered or threaded end connections.

B. Pipe NPS 2 and Smaller:

1. Brass ball valve, one piece.
2. Bronze ball valve, one piece with bronze trim.
3. Brass ball valves, two-piece with full port and brass trim.
4. Bronze ball valves, two-piece with full port and bronze or brass trim.
5. Brass ball valves, three-piece with full port and brass trim.
6. Bronze ball valves, three-piece with full port and bronze or brass trim.
7. Bronze ball valves, two-piece with regular port and bronze trim.

C. Pipe NPS 2-1/2 and Larger:

1. Steel and Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 2. Steel ball valves, Class 150 with full port.
 3. Iron ball valves, Class 150.
- D. Pipe NPS 2 and Smaller: Bronze gate valves, NRS, Class 125 with soldered threaded ends.
- E. Pipe NPS 2-1/2 and Larger: Iron gate valves, NRS, Class 125 with flanged ends.

END OF SECTION

SECTION 220529 HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Pipe positioning systems.
10. Equipment supports.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220548 "Vibration Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.4 ACTION SUBMITTALS

- A. Product Data for each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 1. Trapeze pipe hangers.
 2. Metal framing systems.
 3. Fiberglass strut systems.
 4. Pipe stands.
 5. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Detail fabrication and assembly of trapeze hangers.
 2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.

3. Non-metallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. B-line, an Eaton business.
 - b. Flex-Strut Inc.
 - c. G-Strut.
 - d. Unistrut; Part of Atkore International.
2. Description: Shop or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Electroplated zinc.
8. Paint Coating: Vinyl.

9. Plastic Coating: PVC.
10. Combination Coating.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Anvil International.
 - b. Carpenter & Paterson, Inc.
 - c. Empire Industries, Inc.
 - d. ERICO International Corporation.
 - e. FNW; Ferguson Enterprises, Inc.
 - f. Gripple Inc.
 - g. PHD Manufacturing, Inc.
2. Description: Shop or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with inturred lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Coating: Zinc.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Carpenter & Paterson, Inc.
 2. Clement Support Services.
 3. ERICO International Corporation.
 4. National Pipe Hanger Corporation.
 5. Pipe Shields Inc.
 6. Piping Technology & Products, Inc.
 7. Rilco Manufacturing Co., Inc.
- B. Insulation-Insert Material for Cold Piping:** ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping:** Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Stainless steel.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One or more; plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.

5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.

1. Properties: Non-staining, non-corrosive, and non-gaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricated from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

- C. **Fiberglass Pipe-Hanger Installation:** Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- D. **Metal Framing System Installation:** Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- E. **Fiberglass Strut System Installation:** Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.
- F. **Thermal-Hanger Shield Installation:** Install in pipe hanger or shield for insulated piping.
- G. **Fastener System Installation:**
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- H. **Pipe Stand Installation:**
 - 1. **Pipe Stand Types except Curb-Mounted Type:** Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. **Curb-Mounted-Type Pipe Stands:** Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- I. **Pipe Positioning-System Installation:** Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- J. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- K. **Equipment Support Installation:** Fabricate from welded-structural-steel shapes.
- L. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- M. Install lateral bracing with pipe hangers and supports to prevent swaying.
- N. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- O. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- Q. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099113 "Exterior Painting", Section 099123 "Interior Painting" or Section 099600 "High-Performance Coatings."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use non-metallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary, to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 220548 VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.

- B. Related Requirements: Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.

1.2 ACTION SUBMITTALS

A. Product Data for each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

- B. Shop Drawings: Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment.

- C. Delegated-Design Submittal: For each vibration isolation device. Include design calculations for selecting vibration isolators.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For testing agency.
- C. Welding certificates.
- D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
 - 1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 - 2. Size: Factory or field cut to match requirements of supported equipment.
 - 3. Pad Material: Oil and water resistant with elastomeric properties.
 - 4. Surface Pattern: Smooth pattern.
 - 5. Infused nonwoven cotton or synthetic fibers.
 - 6. Load-bearing metal plates adhered to pads.
 - 7. Sandwich-Core Material: Resilient and elastomeric
 - a. Surface Pattern: Smooth pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.2 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:
 - 1. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
 - 2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:

1. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.5 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top housing with attachment and leveling bolt.

2.6 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint

1. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top plate with threaded mounting holes.
 - c. Internal leveling bolt that acts as blocking during installation.
2. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.7 HOUSED-RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
 1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.
 1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.9 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.
 - 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and re-insertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.10 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
 - 1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 - 2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.11 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
 - 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 - 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 - 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION

SECTION 22 0553 IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.2 ACTION SUBMITTALS

- A. Product Data for each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Brady Corporation.
 - b. Brimar Industries, Inc.
 - c. Carlton Industries, LP.
 - d. Champion America.
 - e. Craftmark Pipe Markers.
 - f. emedco.

- g. Kolbi Pipe Marker Co.
 - h. LEM Products Inc..
2. Material and Thickness: Brass, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 3. Letter Color: Black.
 4. Background Color: White.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Brady Corporation.
 2. Champion America.
 3. Marking Services Inc.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: Red.
- D. Background Color: Yellow.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - 2. Brady Corporation.
 - 3. Brimar Industries, Inc.
 - 4. Carlton Industries, LP.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 STENCILS

- A. Stencils for Piping:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Brimar Industries, Inc.
 - b. Carlton Industries, LP.
 - c. Champion America.
 - d. Craftmark Pipe Markers.
2. Lettering Size: Size letters according to ASME A13.1 for piping.
3. Stencil Material: Fiberboard or metal.
4. Stencil Paint: Exterior, gloss, alkyd enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 2. Brady Corporation.
 3. Brimar Industries, Inc.
 4. Carlton Industries, LP.
- B. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 1. Tag Material: Brass, 0.032-inch stainless steel, 0.025-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link chain or beaded chain or S-hook.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Corporation.
 2. Brimar Industries, Inc.
 3. Carlton Industries, LP.
 4. Champion America.
 5. Craftmark Pipe Markers.
- B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
1. Size: 3 by 5-1/4 inches minimum.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Safety yellow background with black lettering.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surface of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Piping Color Coding: Painting of piping is specified in Section 099000 "Interior Painting."

- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.

- C. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

- D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

- E. Pipe Label Color Schedule:
 - 1. Domestic Water Piping
 - a. Background: Safety green.
 - b. Letter Colors: White.

 - 2. Sanitary Waste Piping:
 - a. Background Color: Safety black.
 - b. Letter Color: White.

 - 3. Storm Drainage Piping:
 - a. Background Color: Safety purple.
 - b. Letter Color: White.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches
 - b. Hot Water: 1-1/2 inches
 2. Valve-Tag Colors:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.
 3. Letter Colors:
 - a. Cold Water: White.
 - b. Hot Water: White.

3.6 WARNING TAG INSTALLATION

- A. Write required message on Tag and attach to equipment and other items where required.

END OF SECTION

SECTION 220716 PLUMBING EQUIPMENT INSULATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes insulating the Domestic water storage tanks.
- B. Related Sections: Section 220719 "Plumbing Piping Insulation."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).
- B. Sustainable Design Submittals:
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail removable insulation at equipment connections and access panels.
 - 4. Detail application of field-applied jackets.
 - 5. Detail application at linkages of control devices.
 - 6. Detail field application for each equipment type.
- D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
 - 1. Sheet Form Insulation Materials: 12 inches square.
 - 2. Sheet Jacket Materials: 12 inches square.
 - 3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

- C. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
 - 1. Equipment Mockups: One tank or vessel
 - 2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
 - 3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 - 4. Obtain Architect's approval of mockups before starting insulation application.
 - 5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 7. Demolish and remove mockups when directed.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with equipment Installer for equipment insulation application.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Equipment Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- A. Calcium Silicate: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Block Insulation: ASTM C552, Type I.
 - 2. Special-Shaped Insulation: ASTM C552, Type III.

3. Board Insulation: ASTM C552, Type IV.
 4. Preformed Pipe Insulation without Jacket: Comply with ASTM C552, Type II, Class 1.
 5. Preformed Pipe Insulation with Factory-Applied [ASJ]: Comply with ASTM C552, Type II, Class 2.
 6. Factory fabricate shapes according to ASTM C450 and ASTM C585.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials and Type II for sheet materials.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- I. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type V, without factory-applied jacket.
- J. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type III, without factory-applied jacket.
- K. Mineral-Fiber, Preformed Pipe Insulation: Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- L. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- M. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C534 or ASTM C1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated unless otherwise indicated.

- B. Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
- C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
- D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- F. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below ambient services.
 - 1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 - 4. Color: White.
- C. Vapor-Retarder Mastic: Solvent based; suitable for outdoor use on below ambient services.
 - 1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 - 2. Service Temperature Range: 0 to 180 deg F.
 - 3. Color: White.
- D. Vapor-Retarder Mastic: Solvent based; suitable for outdoor use on below ambient services.
 - 1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 - 2. Service Temperature Range: Minus 50 to plus 220 deg F.
 - 3. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Water-Vapor Permeance: ASTM 96, greater than 1.0 perm at manufacturer's recommended dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over insulation.
 3. Service Temperature Range: 0 to plus 180 deg F.
 4. Color: White.

2.6 SEALANTS

- A. Joint Sealants for Cellular-Glass Products:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Permanently flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 4. Color: White or gray.
- B. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: Aluminum.
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: White.

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

4. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E96/E96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E84.
5. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E96/E96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E84.
6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering equipment.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for equipment.

2.9 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.

2.10 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Adhesive: As recommended by jacket material manufacturer.
 2. Color: White.
 3. Factory-fabricated tank heads and tank side panels.
- C. Metal Jacket:
 1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper

- d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
2. Stainless-Steel Jacket: ASTM A167 or ASTM A240/A240M.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 1. Width: 3 inches.
 2. Thickness: 11.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
 1. Width: 3 inches.
 2. Thickness: 6.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 1. Width: 2 inches.
 2. Thickness: 6 mils.
 3. Adhesion: 64 ounces force/inch in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 1. Width: 2 inches.
 2. Thickness: 3.7 mils.
 3. Adhesion: 100 ounces force/inch in width.
 4. Elongation: 5 percent.

5. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.
1. Width: 3 inches.
 2. Film Thickness: 6 mils.
 3. Adhesive Thickness: 1.5 mils.
 4. Elongation at Break: 145 percent.
 5. Tensile Strength: 55 lbf/inch in width.

2.12 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal.
2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: zinc-coated, low-carbon steel or Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

- a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - b. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
- a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Zinc-coated, low-carbon steel or Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel 0.062-inch or soft-annealed, galvanized steel.

2.13 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A167 or ASTM A240/A240M, Type 304.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that applies to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.

- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal end at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe, and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of

equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation end around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel or stainless steel, at least 0.050 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Domestic Water Boiler Breechings:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

- 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
- 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
- 3. Completely encapsulate insulation with coating, leaving no exposed insulation.

- B. Where FSK jackets are indicated, install as follows:

- 1. Draw jacket material smooth and tight.
- 2. Install lap or joint strips with same material as jacket.
- 3. Secure jacket to insulation with manufacturer's recommended adhesive.
- 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
- 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

- E. Where PVDC jackets are indicated, install as follows:

- 1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. 33-1/2-inch-circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
- 2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.8 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment that is not factory insulated.
- C. Domestic water pump insulation shall be one of the following:
 - 1. Cellular Glass: 2 inches thick.
 - 2. Mineral-Fiber Blanket: 1 inch thick.

- D. PVC Equipment, Exposed, up to 48 inches in Diameter or with Flat Surfaces up to 72 inches:
 - 1. Aluminum, Smooth: 0.024 inch thick.

- E. Equipment, Exposed, Larger than 48 inches in Diameter or with Flat Surfaces Larger than 72 inches:
 - 1. Aluminum, Smooth with: 0.032 inch thick.

END OF SECTION

SECTION 221116 DOMESTIC WATER PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Ductile-iron pipe and fittings.
3. Galvanized steel pipe and fittings for 4” and larger sizes
4. Piping joining materials.
5. Encasement for piping.
6. Transition fittings.
7. Dielectric fittings.

1.2 ACTION SUBMITTALS

- A. Product Data for transition fittings and dielectric fittings.**

1.3 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.**
- B. Field quality-control reports.**

1.4 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:**
1. Notify Construction Manager no fewer than two days in advance of proposed interruption of water service.
 2. Do not interrupt water service without Construction Manager's written permission.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."
- C. Comply with NSF Standard 372 for low lead.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.
- G. Copper Pressure-Seal-Joint Fittings:
 - 1. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
 - 2. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
- H. Copper Push-on-Joint Fittings:
 - 1. Description:
 - a. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
 - b. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.
- I. Copper-Tube, Extruded-Tee Connections:
 - 1. Description: Tee formed in copper tube according to ASTM F 2014.

- J. Appurtenances for Grooved-End Copper Tubing:
1. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75/B 75M copper tube or ASTM B 584 bronze castings.
 2. Mechanical Couplings for Grooved-End Copper Tubing:
 - a. Copper-tube dimensions and design similar to AWWA C606.
 - b. Ferrous housing sections.
 - c. EPDM-rubber gaskets suitable for hot and cold water.
 - d. Bolts and nuts.
 - e. Minimum Pressure Rating: 300 psig.

2.3 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe:
1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Standard-Pattern, Mechanical-Joint Fittings:
1. AWWA C110/A21.10, ductile or gray iron.
 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- C. Compact-Pattern, Mechanical-Joint Fittings:
1. AWWA C153/A21.53, ductile iron.
 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- D. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.
- E. Appurtenances for Grooved-End, Ductile-Iron Pipe:
1. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions that match pipe.
 2. Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:
 - a. AWWA C606 for ductile-iron-pipe dimensions.
 - b. Ferrous housing sections.
 - c. EPDM-rubber gaskets suitable for hot and cold water.
 - d. Bolts and nuts.
 - e. Minimum Pressure Rating:
 - 1) NPS 14 to NPS 18: 250 psig
 - 2) NPS 20 to NPS 46: 150 psig

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

- A. Galvanized-Steel Pipe:
 - 1. ASTM A 53/A 53M, Type E Grade B Standard Weight.
 - 2. Include ends matching joining method.
- B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.
- C. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- D. Malleable-Iron Unions:
 - 1. ASME B16.39, Class 150.
 - 2. Hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal, bronze seating surface.
 - 4. Threaded ends.
- E. Flanges: ASME B16.1, Class 125, cast iron.
- F. Appurtenances for Grooved-End, Galvanized-Steel Pipe:
 - 1. Fittings for Grooved-End, Galvanized-Steel Pipe:
Galvanized, ASTM A 47/A 47M, malleable-iron casting; ASTM A 106/A 106M, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 - 2. Fittings for Grooved-End, Galvanized-Steel Pipe:
 - a. AWWA C606 for steel-pipe dimensions.
 - b. Ferrous housing sections.
 - c. EPDM-rubber gaskets suitable for hot and cold water.
 - d. Bolts and nuts.
 - e. Minimum Pressure Rating:
 - 1) NPS 8 and Smaller: 600 psig
 - 2) NPS 10 and NPS 12: 400 psig
 - 3) NPS 14 to NPS 24: 250 psig

2.5 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.6 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.
- B. Form: Sheet or tube.
- C. Color: Black or natural

2.7 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
- D. Plastic-to-Metal Transition Fittings:
 - 1. Description:
 - a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - b. One end with threaded brass inserts and one solvent-cement-socket or threaded end.
- E. Plastic-to-Metal Transition Unions:
 - 1. Description:
 - a. CPVC or PVC four-part union.
 - b. Brass or stainless-steel threaded end.
 - c. Solvent-cement-joint or threaded plastic end.
 - d. Rubber O-ring.
 - e. Union nut.

2.8 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Standard: ASSE 1079.
 - 2. Pressure Rating: 125 psig minimum at 180 deg F
 - 3. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Standard: ASSE 1079.
 - 2. Factory-fabricated, bolted, companion-flange assembly.
 - 3. Pressure Rating: 125 psig minimum at 180 deg F
 - 4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
 - 1. Nonconducting materials for field assembly of companion flanges.
 - 2. Pressure Rating: 150 psig
 - 3. Gasket: Neoprene or phenolic.
 - 4. Bolt Sleeves: Phenolic or polyethylene.
 - 5. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
 - 1. Standard: IAPMO PS 66.
 - 2. Electroplated steel nipple complying with ASTM F 1545.
 - 3. Pressure Rating and Temperature: 300 psig at 225 deg F
 - 4. End Connections: Male threaded or grooved.
 - 5. Lining: Inert and noncorrosive, propylene.

PART 3 EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
- H. Install domestic water piping level without pitch and plumb.
- I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548.13 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- L. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- N. Install piping to permit valve servicing.

- O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- P. Install piping free of sags and bends.
- Q. Install fittings for changes in direction and branch connections.
- R. Install PEX tubing with loop at each change of direction of more than 90 degrees.
- S. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- T. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."
- U. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."
- V. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- H. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- I. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- J. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Square cut groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- K. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4 Use dielectric flanges
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 6. NPS 6: 10 feet with 5/8-inch rod.
 - 7. NPS 8: 10 feet with 3/4-inch rod.

- F. Install supports for vertical copper tubing every 10 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 - 7. NPS 6: 12 feet with 3/4-inch rod.
 - 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 - 7. NPS 6: 12 feet with 3/4-inch rod.
 - 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- J. Install supports for vertical stainless-steel piping every 15 feet.
- K. Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.

2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 2. Piping Tests:
 - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

- c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.10 ADJUSTING

- A. Perform the following adjustments before operation:
- 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where they are used and are clean and ready for use.
 - 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
- 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

- a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Clean non-potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.
- ### 3.12 PIPING SCHEDULE
- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
 - B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
 - C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
 - D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be one of the following:
 1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed copper pressure-seal fittings joints.

- E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger shall be one of the following:
1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
 2. Mechanical-joint, ductile-iron pipe; standard or compact pattern, mechanical-joint fittings; and mechanical joints.
 3. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- F. Under-building-slab, domestic water piping, NPS 2 and smaller shall be one of the following:
1. Hard or soft copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.
 2. PVC, Schedule 40 socket fittings; and solvent-cemented joints.
 3. PP, SDR 7.4 SDR 11 socket fittings; and fusion-welded joints.
- G. Aboveground domestic water piping, NPS 2 and smaller shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; cast or wrought- copper, solder-joint fittings; and brazed joints.
 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
 3. Hard copper tube, ASTM B 88, Type L copper push-on-joint fittings; and push-on joints.
- H. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L cast or wrought-copper, solder-joint fittings; and brazed joints.
 2. Hard copper tube, ASTM B 88, Type L or copper pressure-seal-joint fittings; and pressure-sealed joints.
 3. Hard copper tube, ASTM B 88, Type L grooved-joint, copper-tube appurtenances; and grooved joints.
 4. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
 5. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
- I. Aboveground domestic water piping, NPS 5 to NPS 8 shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L cast-or wrought- copper, solder-joint fittings; and brazed joints.
 2. Hard copper tube, ASTM B 88, Type L grooved-joint, copper-tube appurtenances; and grooved joints.

3. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
 4. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
- J. Aboveground, domestic water-service piping, NPS 6 to NPS 12, shall be one of the following:
1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
 2. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
 3. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

3.13 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION

SECTION 221119 DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated, water mixing valves.
6. Strainers.
7. Outlet boxes.
8. Hose stations.
9. Hose bibbs.
10. Wall hydrants.
11. Ground hydrants.
12. Post hydrants.
13. Drain valves.
14. Water-hammer arresters.
15. Air vents.
16. Trap-seal primer valves.
17. Trap-seal primer systems.
18. Specialty valves.
19. Flexible connectors.
20. Water meters.
21. Hot water recirculation pump.

B. Related Requirements: Section 221116 "Domestic Water Piping" for water meters.

1.2 ACTION SUBMITTALS

- A. Product Data for each type of product.
- B. Shop Drawings for domestic water piping specialties. Include diagrams for power, signal, and control wiring.
- C. Sustainable Design Submittals: Product Data for water consumption.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ames Fire & Waterworks; A WATTS Brand.
 - b. Apollo Valves; Conbraco Industries, Inc.
 - c. Cash Acme.
 - d. FEBCO; A WATTS Brand.
 - e. WATTS.
- 2. Standard: ASSE 1001.
- 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
- 4. Body: Bronze.
- 5. Inlet and Outlet Connections: Threaded.
- 6. Finish: Rough bronze in concealed locations or unfinished areas, Chrome plated in finished areas.

- B. Hose-Connection Vacuum Breakers:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Cash Acme.
 - c. Prier Products, Inc.
 - d. WATTS.

- e. Woodford Manufacturing Company.
 2. Standard: ASSE 1011.
 3. Body: Bronze, nonremovable, with manual drain.
 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 5. Finish: Chrome or nickel plated where exposed, Rough bronze in hydrant box.
- C. Pressure Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ames Fire & Waterworks; A WATTS Brand.
 - b. Apollo Valves; Conbraco Industries, Inc.
 - c. FEBCO; A WATTS Brand.
 - d. WATTS
 - e. Zurn Industries, LLC.
 2. Standard: ASSE 1020.
 3. Valves: Ball type, on inlet and outlet.
- D. Laboratory-Faucet Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Woodford Manufacturing Company.
 - d. Zurn Industries, LLC.
 2. Standard: ASSE 1035.
 3. Size: NPS 1/4 or NPS 3/8 matching faucet size.
 4. Body: Bronze.
 5. End Connections: Threaded.
 6. Finish: Chrome plated.
- E. Spill-Resistant Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 2. Standard: ASSE 1056.

3. Operation: Continuous-pressure applications.
4. Size: NPS 1/2
5. Valves: Ball type, on inlet and outlet.

2.4 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Cash Acme.
 - c. FEBCO; A WATTS Brand.
 - d. WATTS.
 - e. Zurn Industries, LLC.
2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Body: Bronze.
5. End Connections: Union, solder joint.
6. Finish: Chrome plated.

B. Reduced-Pressure-Principal Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ames Fire & Waterworks; A WATTS Brand.
 - b. Apollo Valves; Conbraco Industries, Inc.
 - c. FEBCO; A WATTS Brand.
 - d. WATTS.
 - e. Zurn Industries, LLC.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle third of flow range.
5. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Double-Check, Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ames Fire & Waterworks; A WATTS Brand.
 - b. Apollo Valves; Conbraco Industries, Inc.
 - c. FEBCO; A WATTS Brand.
 - d. WATTS.
 - e. Zurn Industries, LLC.
 2. Standard: ASSE 1015.
- D. Beverage-Dispensing-Equipment Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 2. Standard: ASSE 1022.
 3. Operation: Continuous-pressure applications.
 4. Size: NPS 1/4 or NPS 3/8.
 5. Body: Stainless steel.
 6. End Connections: Threaded.
- E. Dual-Check-Valve Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 2. Standard: ASSE 1024.
 3. Operation: Continuous-pressure applications.
 4. Size: NPS ½ - NPS 1 1/4
 5. Body: Bronze with union inlet.
- F. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Cash Acme.
 - b. Lancer Corporation.

c. WATTS.

2. Standard: ASSE 1032.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8.
5. Body: Stainless steel.
6. End Connections: Threaded.

G. Hose-Connection Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Woodford Manufacturing Company.
2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4.
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm flow

H. Backflow-Preventer Test Kits:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Zurn Industries, LLC.
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Cash Acme.
 - c. WATTS.
 - d. Zurn Industries, LLC.

2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.

B. Water-Control Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. CLA-VAL Automatic Control Valves.
 - c. OCV Control Valves.
 - d. WATTS.
2. Description: Pilot-operated, diaphragm-type, single-seated, main water-control valve.
3. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
4. Design Inlet Pressure:
5. Setting:
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

2.6 BALANCING VALVES

A. Memory-Stop Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Bell and Gossett.
 - c. NIBCO INC
2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.7 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Lawler Manufacturing Company, Inc.
 - c. Leonard Valve Company.
 - d. POWERS; A WATTS Brand.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.

B. Manifold, Thermostatic, Water Mixing-Valve Assemblies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Lawler Manufacturing Company.
 - b. Leonard Valve Company.
 - c. POWERS; A WATTS Brand.
2. Description: Factory-fabricated, thermostatically controlled, water mixing-valve assembly in two-valve parallel arrangement.
3. Large-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gages on inlet and outlet.
4. Intermediate-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gages on inlet and outlet.
5. Small-Flow Parallel: Thermostatic, water mixing valve.
6. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
7. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
8. Pressure Rating: 125 psig minimum unless otherwise indicated.

C. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Lawler Manufacturing Company, Inc.
 - c. Leonard Valve Company.
 - d. POWERS; A WATTS Brand.
2. Standard: ASSE 1070, thermostatically controlled, water tempering valve.

3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: 109 deg F.
9. Tempered-Water Design Flow Rate: 0.5-11 gpm.

D. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
 - c. Strainers NPS 5 and Larger: 0.10 inch.
6. Drain: Pipe plug.

2.8 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include ACORN – 8180.
2. Mounting: Recessed.
3. Material and Finish: Stainless Steel.
4. Faucet: Combination valve fitting or separate hot- and cold-water valve fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
6. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.
7. Inlet Hoses: Two 60-inch-long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
8. Drain Hose: One 48-inch-long, rubber household clothes washer drain hose with hooked end.

B. Icemaker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. IPS Corporation.
 - b. Oatey.
 - c. Plastic Oddities.
2. Mounting: Recessed.
3. Material and Finish: Enameled-steel, epoxy-painted-steel, or plastic box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.9 HOSE STATIONS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Armstrong International, Inc.
 2. Leonard Valve Company.
 3. T&S Brass and Bronze Works, Inc.
- B. Single-Temperature-Water Hose Stations:
 1. Standard: ASME A112.18.1.
 2. Cabinet: Stainless-steel enclosure with exposed valve handle, hose connection, and hose rack. Include thermometer in front.
 3. Hose-Rack Material: Stainless steel.
 4. Body Material: Bronze with stainless-steel wetted parts.
 5. Body Finish: Rough bronze, chrome plated.
 6. Mounting: Wall, with reinforcement.
 7. Supply Fittings: NPS 3/4 gate, globe, or ball valve and check valve and NPS 3/4 copper, water tubing. Omit check valve if check stop is included with fitting.
 8. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 25 feet long.
 9. Nozzle: With hand-squeeze, on-off control.
 10. Vacuum Breaker:
 - a. Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7 on outlet.
- C. Hot- and Cold-Water Hose Stations:

1. Standard: ASME A112.18.1.
2. Faucet Type: Blending valve.
3. Cabinet: Stainless-steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
4. Hose-Rack Material: Stainless steel.
5. Body Material: Bronze with stainless-steel wetted parts.
6. Body Finish: Rough bronze or chrome plated.
7. Mounting: Wall, with reinforcement.
8. Supply Fittings: Two NPS 3/4 gate, globe, or ball valves and check valves and NPS 3/4 copper, water tubing. Omit check valves if check stops are included with fitting.
9. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 25 feet long.
10. Nozzle: With hand-squeeze, on-off control.
11. Vacuum Breaker: Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

D. Cold-Water and Steam Hose Stations:

1. Standard: ASME A112.18.1.
2. Faucet Type: Blending valve.
3. Cabinet: Stainless-steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
4. Hose-Rack Material: Stainless steel.
5. Body Material: Bronze with stainless-steel wetted parts.
6. Body Finish: Rough bronze or chrome plated.
7. Mounting: Wall, with reinforcement.
8. Supply Fittings: Two NPS 3/4 gate, globe, or ball valves and check valves and NPS 3/4 copper, water tubing. Omit check valves if check stops are included with fitting.
9. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 25 feet long.
10. Nozzle: With hand-squeeze, on-off control.
11. Vacuum Breaker:
 - a. Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.10 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.

2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include wall flange with each chrome- or nickel-plated hose bibb.

2.11 WALL HYDRANTS

A. Non-freeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Prier Products, Inc.
 - b. WATTS.
 - c. Woodford Manufacturing Company.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.21.3M for exposed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Polished nickel bronze.
12. Operating Keys(s): One with each wall hydrant.

B. Non-freeze, Hot- and Cold-Water Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Prier Products, Inc.
 - b. WATTS.
 - c. Woodford Manufacturing Company.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.21.3M for concealed outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rods: Of length required to match wall thickness. Include wall clamps.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Vacuum Breaker:
 - a. Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7 on outlet.
11. Operating Key(s): One with each wall hydrant.

2.12 POST HYDRANTS

A. Non-freeze, Nondraining-Type Post Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Murdock-Super Secur; a member of Morris Group International.
2. Operation: Lever-piston operating mechanism and nondraining water-storage reservoir, designed without drain.
3. Length: As required for burial of valve below frost line.
4. Inlet: NPS 1 threaded.
5. Outlet:
 - a. NPS 1 outlet and coupling plug for 1-inch hose.
 - b. NPS 1 by NPS 3/4 adapter with nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
 - c. Garden-hose thread complying with ASME B1.20.7 on outlet.
 - d. NPS 1 by NPS 3/4 adapter with nonremovable, drainable, hose-connection backflow preventer complying with ASSE 1052.
 - e. Garden-hose thread complying with ASME B1.20.7 on outlet.

B. Freeze-Resistant Sanitary Yard Hydrants

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include Hoepfner Products.
2. Standard: ASSE 1057, Type 5 for nondraining hydrants.
3. Operation: Wheel handle.
4. Head: Copper alloy, with pail hook.
5. Inlet: NPS 3/4-inch threaded inlet and inlet nozzle, galvanized-steel riser, and venturi.
6. Canister: Zinc-plated steel with atmospheric-vent device.
7. Vacuum Breaker:
 - a. Removable hose-connection backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7 on outlet for field installation.

2.13 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.

3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.14 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Precision Plumbing Products.
 - b. Sioux Chief Manufacturing Company, Inc.
 - c. WATTS.
 - d. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Copper tube with piston.
3. Size: ASSE 1010, Sizes AA and A thru F, or PDI-WH 201, Sizes A thru F.

2.15 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Precision Plumbing Products.
 - b. Sioux Chief Manufacturing Company, Inc.
 - c. WATTS.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Standard.
 - b. Jay R. Smith Mfg. Co.

c. Sloan Valve.

2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection or water closet down-tube type.
3. Size: NPS 1-1/4 minimum.
4. Material: Chrome-plated, cast brass.

2.16 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Precision Plumbing Products.
 - b. Zurn Industries, LLC.
2. Standard: ASSE 1044.
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: Surface-mounted steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
7. Vacuum Breaker: ASSE 1001.
8. Size Outlets: NPS 1/2.

2.17 SPECIALTY VALVES

A. Comply with requirements for general-duty metal valves in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."

2.18 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Flex-Hose Co., Inc.
 2. Flexicraft Industries.
 3. Flex-Weld, Inc.
 4. Universal Metal Hose.

- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - 1. Working-Pressure Rating: Minimum 200 psig.
 - 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 - 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 - 1. Working-Pressure Rating: Minimum 200 psig.
 - 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 - 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.19 WATER METERS

- A. Displacement-Type Water Meters:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Mueller Co.
 - b. Schlumberger Limited.
 - c. Sensus.
 - 2. Description:
 - a. Standard: AWWA C700.
 - b. Pressure Rating: 150-psig working pressure.
 - c. Body Design: Nutating disc; totalization meter.
 - d. Registration: In gallons or cubic feet as required by utility company.
 - e. Case: Bronze.
 - f. End Connections: Threaded.

- B. Turbine-Type Water Meters:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Badger Industries, Inc.
 - b. Mueller Co.
 - c. Schlumberger Limited.
 - d. Sensus.
 - 2. Description:
 - a. Standard: AWWA C701.

- b. Pressure Rating: 150-psig working pressure.
- c. Body Design: Turbine; totalization meter.
- d. Registration: In gallons or cubic feet as required by utility company.
- e. Case: Bronze.
- f. End Connections for Meters NPS 2 and Smaller: Threaded.
- g. End Connections for Meters NPS 2-1/2 and Larger: Flanged.

C. Compound-Type Water Meters:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Badger Industries, Inc.
 - b. Mueller Co.
 - c. Schlumberger Limited.
 - d. Sensus.
- 2. Description:
 - a. Standard: AWWA C702.
 - b. Pressure Rating: 150-psig working pressure.
 - c. Body Design: With integral mainline and bypass meters; totalization meter.
 - d. Registration: In gallons or cubic feet as required by utility company.
 - e. Case: Bronze.
 - f. Pipe Connections: Flanged.

D. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

E. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device

- attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
 - C. Install water-control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.
 - D. Install balancing valves in locations where they can easily be adjusted.
 - E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet. Install cabinet-type units recessed in or surface mounted on wall as specified.
 - F. Install Y-pattern strainers for water on supply side of each control valve water pressure-reducing valve solenoid valve and pump.
 - G. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
 - H. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
 - I. Set non-freeze, nondraining-type post hydrants in concrete or pavement.
 - J. Set freeze-resistant yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.
 - K. Install water-hammer arresters in water piping according to PDI-WH 201.
 - L. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
 - M. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
 - N. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

- O. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

- A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Intermediate atmospheric-vent backflow preventers.
 - 3. Reduced-pressure-principal backflow preventers.
 - 4. Double-check, backflow-prevention assemblies.
 - 5. Carbonated-beverage-machine backflow preventers.
 - 6. Dual-check-valve backflow preventers.
 - 7. Reduced-pressure-detector, fire-protection, backflow-preventer assemblies.
 - 8. Double-check, detector-assembly backflow preventers.
 - 9. Water pressure-reducing valves.
 - 10. Calibrated balancing valves.
 - 11. Primary, thermostatic, water mixing valves.
 - 12. Manifold, thermostatic, water mixing-valve assemblies.
 - 13. Photographic-process, thermostatic, water mixing-valve assemblies.
 - 14. Primary water tempering valves.
 - 15. Outlet boxes.
 - 16. Hose stations.
 - 17. Supply-type, trap-seal primer valves.
 - 18. Trap-seal primer systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Test each pressure vacuum breaker reduced-pressure-principal backflow preventer double-check, backflow-prevention assembly and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION

SECTION 221123 FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Pipes, tubes, and fittings.
 2. Piping specialties.
 3. Piping and tubing joining materials.
 4. Manual gas shutoff valves.
 5. Earthquake valves.
 6. Pressure regulators.
 7. Dielectric fittings.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
1. Piping specialties.
 2. Corrugated, stainless-steel tubing with associated components.
 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 4. Pressure regulators. Indicate pressure ratings and capacities.
 5. Service meters. Indicate pressure ratings and capacities. Include bypass fittings and meter bars.
 6. Dielectric fittings.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same

to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.
2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

C. For natural-gas piping and equipment indicated to comply with performance requirements and design criteria.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

C. Qualification Data: For qualified professional engineer.

D. Welding certificates.

E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.8 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Construction Manager no fewer than two days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Construction Manager's written permission.

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 65 psig minimum unless otherwise indicated.

3. Minimum Operating Pressure of Service Meter: 2 psig.
4. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

2.2 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
6. Mechanical Couplings:
 - a. Steel flanges and tube with epoxy finish.
 - b. Buna-nitrile seals.
 - c. Steel bolts, washers, and nuts.
 - d. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - e. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

B. PE Pipe: ASTM D2513, SDR 11.

1. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.

2.3 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

B. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

C. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.

3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
 4. CWP Rating: 750 psig.
- E. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.5 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 1. CWP Rating: 125 psig.
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 1. CWP Rating: 125 psig.
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.

3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B 584.
 2. Ball: Chrome-plated brass.
 3. Stem: Bronze; blowout proof.
 4. Seats: Reinforced TFE; blowout proof.
 5. Packing: Separate packnut with adjustable-stem packing threaded ends.
 6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. CWP Rating: 600 psig.
 8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Bronze Plug Valves: MSS SP-78.
1. Body: Bronze, complying with ASTM B 584.
 2. Plug: Bronze.
 3. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Operator: Square head or lug type with tamperproof feature where indicated.
 5. Pressure Class: 125 psig.
 6. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
1. Body: Cast iron, complying with ASTM A 126, Class B.
 2. Plug: Bronze or nickel-plated cast iron.
 3. Seat: Coated with thermoplastic.
 4. Stem Seal: Compatible with natural gas.
 5. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 6. Operator: Square head or lug type with tamperproof feature where indicated.
 7. Pressure Class: 125 psig.
 8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- G. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
9. Overpressure Protection Device: Factory mounted on pressure regulator.
10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
11. Maximum Inlet Pressure: 100 psig.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Body and Diaphragm Case: Die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber.
5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.

7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
8. Maximum Inlet Pressure: 0.5 psig.

2.7 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined
- B. Dielectric Unions:
 1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 1. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 125 psig minimum at 180 deg F.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous
- D. Dielectric-Flange Insulating Kits:
 1. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

2.8 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe.
- E. Copper Tubing with Protective Coating:
 - 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

- F. Install fittings for changes in direction and branch connections.
- G. Install pressure gage downstream from each service regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."

3.4 INDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 5. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use natural-gas piping as grounding electrode.

- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install pressure gage downstream from each line regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.5 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.7 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

D. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
 2. NPS 1/2 and NPS 5/8: Maximum span, 72 inches; minimum rod size, 3/8 inch.
 3. NPS 3/4 and NPS 7/8: Maximum span, 84 inches; minimum rod size, 3/8 inch.
 4. NPS 1: Maximum span, 96 inches; minimum rod size, 3/8 inch.
- E. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
 2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
 3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.8 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

- A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (flat).
 - d. Color: Gray.

- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex (flat).
 - d. Color: Gray.

 2. Alkyd System: MPI INT 5.1E.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd (flat).
 - d. Color: Gray.

- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.
 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Use 3000-psi, 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.12 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections: Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.13 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.14 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be one of the following:
 - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
 - 2. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
- B. Aboveground natural-gas piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed joints. Install piping embedded in concrete with no joints in concrete.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
 - 1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
 - 2. Steel pipe with malleable-iron fittings and threaded joints.

- B. Aboveground, distribution piping shall be one of the following
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Underground, below building, piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.16 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with steel welding fittings and welded joints.
 - 3. Drawn-temper copper tube with wrought-copper fittings and brazed joints.
- C. Underground, below building, piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.17 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground:

1. NPS 2 and Smaller: Bronze plug valves.
2. NPS 2-1/2 and Larger: Cast-iron, nonlubricated plug valves.

3.18 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

E. Valves in branch piping for single appliance shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

END OF SECTION

SECTION 221313 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. PVC pipe and fittings.
 - 2. Cleanouts.
 - 3. Manholes.
 - 4. Concrete.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Pipe and fittings.
 - 2. Cleanouts.
- B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 - 1. Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- B. Product Certificates: For each type of pipe and fitting.
- C. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

1.6 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Architect no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Architect's written permission.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

- A. PVC Cellular-Core Sewer Piping:
 - 1. Pipe: ASTM F891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
 - 2. Fittings: ASTM D3034, SDR 35, PVC socket-type fittings.

2.2 CLEANOUTS

- A. Cast-Iron Cleanouts:
 - 1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
 - 2. Top-Loading Classification(s): Heavy Duty.
 - 3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

2.3 MANHOLES

- A. Standard Precast Concrete Manholes:
 - 1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 - 2. Diameter: 48 inches minimum unless otherwise indicated.
 - 3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
 - 4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.

5. Riser Sections: 4-inch minimum thickness, of length to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, PP; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch- minimum-width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A536, Grade 60-40-18 ductile iron unless otherwise indicated.

C. Manhole-Cover Inserts:

1. Description; Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
2. Type: Solid.

2.4 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350, and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 2 percent through manhole.
 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 4 percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow, nonpressure, drainage piping according to the following:
 1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.

2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 3. Install piping with 36-inch minimum cover.
 4. Install PVC cellular-core sewer piping according to ASTM D2321 and ASTM F1668.
- F. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping according to the following:
1. Join PVC cellular-core sewer piping according to ASTM D2321 and ASTM F891 for solvent-cemented joints.
 2. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.

3.4 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C891.
- C. Form continuous concrete channels and benches between inlets and outlet.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.
- E. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.6 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
1. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.7 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."
- B. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of, and be flush with, inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
 - a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
 - 4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.8 IDENTIFICATION

- A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
 - 1. Use warning tape or detectable warning tape over ferrous piping.
 - 2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate report for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
 - a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
 - b. Close openings in system and fill with water.
 - c. Purge air and refill with water.
 - d. Disconnect water supply.
 - e. Test and inspect joints for leaks.
 - 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Test plastic gravity sewer piping according to ASTM F1417.
 - 7. Manholes: Perform hydraulic test according to ASTM C969.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

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3.10 CLEANING

- A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 221313

SECTION 221316 SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.2 ACTION SUBMITTALS

- A. Product Data for each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

1.4 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 2. Waste, Force-Main Piping: 50 psig.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 PIPING MATERIALS

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class(es).
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. AB&I Foundry.
 - b. Charlotte Pipe and Foundry Company.
 - c. Tyler Pipe; a subsidiary of McWane Inc.

- B. Single-Stack Aerator Fittings: ASME B16.45, hubless, cast-iron aerator and deaerator drainage fittings.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by Conine

- C. CISPI, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. Fernco Inc.
 - c. Josam Company.
 - d. MIFAB, Inc.
 - e. Tyler Pipe; a subsidiary of McWane Inc.
 - 2. Standards: ASTM C 1277 and CISPI 310.
 - 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

- D. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. Clamp-All Corp.
 - c. Mission Rubber Company, LLC; a division of MCP Industries.
 - 2. Standards: ASTM C 1277 and ASTM C 1540.
 - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

- E. Cast-Iron, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. MG Piping Products Company.
 - 2. Standard: ASTM C 1277.
 - 3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
2. Unshielded, Non-pressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Froet Industries LLC.
 - 4) Mission Rubber Company, LLC; a division of MCP Industries.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.
 - e. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
3. Shielded, Non-pressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company, LLC; a division of MCP Industries.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.
4. Pressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Dresser, Inc.
 - 2) Jay R. Smith Mfg. Co.
 - 3) Viking Johnson.

- b. Standard: AWWA C219.
- c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
- d. Center-Sleeve Material: Carbon steel or Ductile iron
- e. Gasket Material: Natural or synthetic rubber.
- f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. Dielectric Unions:

- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Jomar Valve.
 - 2) WATTS.
 - 3) Wilkins.
 - 4) Zurn Industries, LLC.
- b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 125 psig minimum at 180 deg F.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.

2. Dielectric Flanges:

- a. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 125 psig minimum at 180 deg F.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

3. Dielectric-Flange Insulating Kits:

- a. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig.
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel backing washers.

4. Dielectric Nipples:

- a. Description:
 - 1) Standard: IAPMO PS 66.
 - 2) Electroplated steel nipple.
 - 3) Pressure Rating: 300 psig at 225 deg F.
 - 4) End Connections: Male threaded or grooved.
 - 5) Lining: Inert and noncorrosive, propylene.

PART 3 EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312316 “Excavation”, Section 312317 “Trenching” and Section 312323 “Fill”.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 - 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 - 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
 - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
 - 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines.
 - 3. Do not change direction of flow more than 90 degrees.

4. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of waste piping in direction of flow is prohibited.
- K. Lay buried building waste piping beginning at low point of each system.
1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 3. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 2-1/2 and smaller; 1 percent downward in direction of flow for piping NPS 3 and larger.
 2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Install engineered soil and waste and vent piping systems as follows:
1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- O. Install underground, ductile-iron, force-main piping according to AWWA C600.
1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
 2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 3. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- P. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

- Q. Install force mains at elevations indicated.
- R. Plumbing Specialties:
 - 1. Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 3. Install drains in sanitary waste gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
- S. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
 - 1. Cut threads full and clean using sharp dies.

2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - c. Do not use pipe sections that have cracked or open welds.
- E. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- F. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Unshielded, non-pressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:
 - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
 - b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

- A. Comply with requirements in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping" for general-duty valve installation requirements.
- B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
 2. Install gate or full-port ball valve for piping NPS 2 and smaller.
 3. Install gate valve for piping NPS 2-1/2 and larger.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
 2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
 3. Install backwater valves in accessible locations.
 4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment." Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- D. Support vertical piping and tubing at base and at each floor.

- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 - 5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
 - 6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3: 12 feet with 1/2-inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 - 7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
 - 8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.
- I. Install supports for vertical steel piping every 15 feet.
- J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 2: 84 inches with 3/8-inch rod.
 - 2. NPS 3: 96 inches with 1/2-inch rod.
 - 3. NPS 4: 108 inches with 1/2-inch rod.
 - 4. NPS 6: 10 feet with 5/8-inch rod.
- K. Install supports for vertical stainless-steel piping every 10 feet.
- L. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.

5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

M. Install supports for vertical copper tubing every 10 feet.

N. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

O. Install supports for vertical PVC piping every 48 inches.

P. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves in pit with pit cover flush with floor.
6. Comply with requirements for backwater valves cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
7. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

- a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
- a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow to stand for four hours.
 - b. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

- E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
 - 3. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.
- C. Aboveground, vent piping shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
 - 3. Copper Type DWV tube, copper drainage fittings, and soldered joints. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
 - 4. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.
- D. Underground, soil, waste, and vent piping shall be any of the following:
 - 1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty cast-iron hubless-piping couplings; and coupled joints.
 - 3. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
 - 4. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.
- E. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 the following:
 - 1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 - 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
- F. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 shall be any of the following:
 - 1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 - 2. Galvanized-steel pipe, pressure fittings, and threaded joints.

3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
- G. Underground sanitary-sewage force mains shall be the following:
1. Hard copper tube, Type L; wrought-copper pressure fittings; and soldered joints.
 2. Ductile-iron, mechanical-joint piping and mechanical joints.
 3. Ductile-iron, push-on-joint piping and push-on joints.
 4. Ductile-iron, grooved-joint piping and grooved joints.
 5. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

END OF SECTION

SECTION 221319 SANITARY WASTE AND VENT PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backwater valves.
2. Cleanouts.
3. Roof flashing assemblies.
4. Through-penetration firestop assemblies.
5. Drain assemblies.
6. Drains
7. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:

1. Section 221423 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.
2. Section 334100 "Storm Utility Drainage Piping" for storm drainage piping and piping specialties outside the building.

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene.
- E. PE: Polyethylene.
- F. PP: Polypropylene.
- G. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

A. Shop Drawings:

1. Show fabrication and installation details for frost-resistant vent terminals.

2. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For FOG disposal systems, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.

2.2 BACKWATER VALVES

- A. Horizontal, Cast-Iron Backwater Valves:
 1. Standard: ASME A112.14.1.
 2. Size: Same as connected piping.
 3. Body: Cast iron.
 4. Cover: Cast iron with bolted or threaded access check valve.
 5. End Connections: Hub and spigot or hubless.
 6. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.

7. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves

1. Size: Same as floor drain outlet.
2. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
3. Check Valve: Removable ball float.
4. Inlet: Threaded.
5. Outlet: Threaded or spigot.

C. Horizontal, Plastic Backwater Valves

1. Size: Same as connected piping.
2. Body: ABS
3. Cover: Same material as body with threaded access to check valve.
4. Check Valve: Removable swing check.
5. End Connections: Socket type.

2.3 CLEANOUTS

A. Cast-Iron Exposed Cleanouts

1. Standard: ASME A112.36.2M.
2. Size: Same as connected drainage piping
3. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts

1. Standard: ASME A112.36.2M for adjustable housing cast-iron soil pipe with cast-iron ferrule cleanout.
2. Size: Same as connected branch.
3. Type: Adjustable housing cast-iron soil pipe with cast-iron ferrule cleanout.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Not required.
6. Outlet Connection: Spigot or Threaded.
7. Closure: Brass plug with straight threads and gasket
8. Adjustable Housing Material: Cast iron
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy
10. Frame and Cover Shape: Round
11. Top Loading Classification: Extra Heavy Duty.

12. Riser: ASTM A 74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts

1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure Plug:
 - a. Brass
 - b. Countersunk or raised head.
 - c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as or not more than one size smaller than cleanout size.
5. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
6. Wall Access: Round nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies

1. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - a. Open-Top Vent Cap: Without cap.
 - b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 - c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES.

A. Through-Penetration Firestop Assemblies:

1. Standard: UL 1479 assembly of sleeve-and-stack fitting with firestopping plug.
2. Size: Same as connected soil, waste, or vent stack.
3. Sleeve: Molded-PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
4. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
5. Special Coating: Corrosion resistant on interior of fittings.

2.6 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.7 DRAINS

- A. See Drain Schedule on Drawing P-000.

2.8 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains

- 1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564 rubber gaskets.
- 2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps

- 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
- 2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch-minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings

- 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
- 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Air-Gap Fittings

- 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
- 2. Body: Bronze or cast iron.
- 3. Inlet: Opening in top of body.
- 4. Outlet: Larger than inlet.
- 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints

1. Standard: ASME A112.6.4.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Equipment Mounting: Install FOG disposal systems on cast-in-place concrete equipment base. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
- B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- H. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations. Comply with requirements in Section 078413 "Penetration Firestopping."
- I. Assemble open drain fittings and install with top of hub above floor.
- J. Install deep-seal traps on floor drains and other waste outlets.
- K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- L. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- M. Install vent caps on each vent pipe passing through roof.
- N. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- P. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- Q. Assemble components of FOG disposal systems and install on floor.
1. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction.

2. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated.
 3. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.
- R. Install wood-blocking reinforcement for wall-mounting-type specialties.
- S. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- T. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
 3. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- U. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- V. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems. Install on support devices, so that top will be flush with adjacent surface.
- W. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.
- X. Install plastic channel drainage system components on support devices, so that top will be flush with adjacent surface.
- Y. Install open drain fittings with top of hub 1 inch above floor.
- 3.2 CONNECTIONS
- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Install piping adjacent to equipment to allow service and maintenance.
- C. FOG Disposal Systems: Connect inlet and outlet to unit, connect flow-control fitting and fresh-air inlet piping to unit inlet piping, and connect vent piping between trap and media chamber. Connect electrical power.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FLASHING INSTALLATION

- A. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- B. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.
- C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- D. Set flashing on floors and roofs in solid coating of bituminous cement.
- E. Secure flashing into sleeve and specialty clamping ring or device.
- F. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."
- G. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections, and prepare test reports. Manufacturer's Field Service. Engage a factory-authorized service representative to inspect field-assembled FOG disposal systems and their installation, including piping and electrical connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain FOG disposal systems. Refer to Section 017900 "Demonstration and Training."

END OF SECTION

SECTION 221413 FACILITY STORM DRAINAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hubless, cast-iron soil pipe and fittings.
2. PVC pipe and fittings.
3. Specialty pipe and fittings.

B. Related Requirements:

1. Section 221429 "Sump Pumps" for storm drainage pumps.
2. Section 334400 "Stormwater Utility Equipment" for storm drainage piping outside the building.

1.2 ACTION SUBMITTALS

- A. Product Data for each type of product.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Detail storm drainage piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved: Structural members to which drainage piping will be attached or suspended from.
- B. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of storm drainage service.
2. Do not proceed with interruption of storm drainage service without Construction Manager's written permission.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
1. Storm Drainage Piping: 10-foot head of water
 2. Storm Drainage, Force-Main Piping: 100 psig

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings:
1. Marked with CISPI collective trademark and NSF certification mark.
 2. Standard: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
1. Couplings shall bear CISPI collective trademark.
 2. Standards: ASTM C 1277 and CISPI 310.
 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- C. Heavy-Duty, Hubless-Piping Couplings:
1. Standard: ASTM C 1540.
 2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- D. Cast-Iron, Hubless-Piping Couplings:
1. Standard: ASTM C 1277.
 2. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 PVC PIPE AND FITTINGS

- A. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

- B. Solid-Wall PVC Pipe: ASTM D 2665; drain, waste, and vent.
- C. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
- D. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- E. Adhesive Primer: ASTM F 656.
- F. Solvent Cement: ASTM D 2564.

2.4 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
 - 3. Unshielded, Non-pressure Transition Couplings:
 - a. Standard: ASTM C 1173.
 - b. Description: Elastomeric sleeve, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 - 4. Shielded, Non-pressure Transition Couplings:
 - a. Standard: ASTM C 1460.
 - b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. End Connections: Same size as and compatible with pipes to be joined.
 - 5. Pressure Transition Couplings:
 - a. Standard: AWWA C219.
 - b. Description: Metal, sleeve-type couplings same size as pipes to be joined, and with pressure rating at least equal to and ends compatible with pipes to be joined.
 - c. Center-Sleeve Material: Manufacturer's standard.
 - d. Gasket Material: Natural or synthetic rubber.
 - e. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
 - a. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 150 psig minimum at 180 deg F.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
3. Dielectric Flanges:
 - a. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 150 psig minimum at 180 deg F.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
4. Dielectric-Flange Insulating Kits:
 - a. Description:
 - 1) Non-conducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig.
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel-backing washers.
5. Dielectric Nipples:
 - a. Description: Electroplated steel nipple.
 - b. Standard: IAPMO PS 66.
 - c. Pressure Rating: 300 psig at 225 deg F.
 - d. End Connections: Male threaded or grooved.
 - e. Lining: Inert and noncorrosive, propylene.

PART 3 EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 2. Install piping as indicated unless deviations from layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
1. Do not change direction of flow more than 90 degrees.
 2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of drainage piping in direction of flow is prohibited.
- L. Lay buried building piping beginning at low point of each system.
1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 3. Maintain swab in piping and pull past each joint as completed.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings." Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

- N. Install underground PVC piping according to ASTM D 2321.
- O. Install underground, ductile-iron, force-main piping according to AWWA C600.
 - 1. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints.
 - 2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 - 3. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- P. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
 - 1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- Q. Install force mains at elevations indicated.
- R. Plumbing Specialties:
 - 1. Install backwater valves in storm drainage gravity-flow piping. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."
 - 2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
 - 3. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."
- S. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
 - a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
 - b. Provide rigid sway bracing for pipe and fittings and larger, upstream and downstream of all changes in direction 45 degrees and greater.
 - c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: Unshielded, non-pressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.
4. In Underground Force-Main Piping:
 - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
 - b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller:
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

A. General valve installation requirements for general-duty valve installations are specified in the following Sections:

1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.14 "Check Valves for Plumbing Piping."
3. Section 220523.15 "Gate Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sump pump discharge.
2. Install gate for piping NS 2 and smaller.

3. Install gate valve for piping NPS 2-1/2 and larger.
- C. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
 2. Install backwater valves in accessible locations.
 3. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
2. Install horizontal backwater valves in pit with pit cover flush with floor.
3. Comply with requirements for backwater valves, cleanouts and drains specified in Section 221423 "Storm Drainage Piping Specialties."

D. Connect force-main piping to the following:

1. Storm Sewer: To exterior force main.
2. Sump Pumps: To sump pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed storm drainage piping.

- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure:
 - a. Test storm drainage piping on completion of roughing-in.
 - b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.
- C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

4. Prepare reports for tests and required corrective action.
- D. Piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping NPS 6 and smaller shall be Hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.
- C. Aboveground, storm drainage piping NPS 8 and larger shall be Hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.
- D. Underground storm drainage piping NPS 6 and shall be Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- E. Underground, storm drainage piping NPS 8 shall be Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
- F. Above ground storm drainage force mains NPS 1-1/2 and NPS 2 shall be any of the following:
 1. Hard copper tube, Type L copper pressure fittings, and soldered joints.
 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
- G. Aboveground storm drainage force mains NPS 2-1/2 to NPS 6 shall be any of the following:
 1. Hard copper tube, Type L copper pressure fittings, and soldered joints.
 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
 3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
 4. Fitting-type transition couplings if dissimilar pipe materials.

- H. Underground storm drainage force mains NPS 4 and smaller shall be any of the following: Retain one or more of first four subparagraphs below. If using more than one type of material and joining method, identify various materials on Drawings and show points of transition from one material to another.
1. Hard copper tube; Type L wrought-copper pressure fittings; and soldered joints.
 2. Ductile-iron, mechanical-joint piping and mechanical joints.
 3. Ductile-iron, push-on-joint piping and push-on joints.
 4. Ductile-iron, grooved-joint piping and grooved joints.
 5. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.
- I. Underground storm drainage force mains NPS 5 and larger shall be any of the following:
1. Hard copper tube; Type L wrought-copper pressure fittings; and soldered joints.
 2. Ductile-iron, mechanical-joint piping and mechanical joints.
 3. Ductile-iron, push-on-joint piping and push-on joints.
 4. Ductile-iron, grooved-joint piping and grooved joints.
 5. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION

SECTION 221423 STORM DRAINAGE PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.
4. Backwater valves.
5. Through-penetration firestop assemblies.
6. Flashing materials.

1.2 ACTION SUBMITTALS

- A. Product Data for each type of product indicated.**

1.3 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.**

PART 2 PRODUCTS

2.1 DRAINS

- A. See Drain Schedule on Drawing P-801**

2.2 CLEANOUTS

A. Floor Cleanouts

1. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
2. Size: Same as connected branch.
3. Type: Adjustable housing.
4. Body or Ferrule Material: PVC.
5. Clamping Device: Not required.
6. Outlet Connection: Threaded.
7. Closure: Plastic plug.
8. Adjustable Housing Material: Plastic with threads.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy

10. Frame and Cover Shape: Round.
11. Top-Loading Classification: Heavy Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Test Tees

1. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
2. Size: Same as connected drainage piping.
3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure Plug: Countersunk or raised head.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

C. Wall Cleanouts

1. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
2. Size: Same as connected drainage piping.
3. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
7. Wall Access: Round nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.3 BACKWATER VALVES

A. Cast-Iron, Horizontal Backwater Valves

1. Standard: ASME A112.14.1, for backwater valves.
2. Size: Same as connected piping.
3. Body Material: Cast iron.
4. Cover: Cast iron with bolted or threaded access check valve.
5. End Connections: hubless.
6. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
7. Extension: ASTM A 74, Service class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Cast-Iron, Drain-Outlet Backwater Valves

1. Body Material: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
2. Check Valve: Removable ball float.

3. Inlet: Threaded.
4. Outlet: Threaded or spigot.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies

1. Standard: ASTM E 814, for through-penetration firestop assemblies.
2. Size: Same as connected pipe.
3. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
4. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
5. Special Coating: Corrosion resistant on interior of fittings.

2.5 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft.
- B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.
- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
 1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 2. Install expansion joints, if indicated, in roof drain outlets.
 3. Position roof drains for easy access and maintenance.

- B. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- C. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
 - 1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 - 3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate cleanouts at base of each vertical soil and waste stack.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install horizontal backwater valves in floor with cover flush with floor.
- G. Install drain-outlet backwater valves in outlet of drains.
- H. Install test tees in vertical conductors and near floor.
- I. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- J. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.
- K. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- L. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.
- M. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 221429 SUMP PUMPS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes Submersible sump pumps.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Wiring Diagrams: For power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS

- A. See Pump Schedules on Drawing P-801.

PART 3 EXECUTION

3.1 EARTHWORK

- A. Excavation and filling are specified in Section 312000 "Earth Moving."

3.2 EXAMINATION

- A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.3 INSTALLATION

- A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Pumps and controls will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service. Complete installation and startup check according to manufacturer's written instructions.

3.6 ADJUSTING

- A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust control set points.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION

SECTION 223400 FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Gas-fired, tankless, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

- A. Product Data for each type of product.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.
- B. Seismic Qualification Data: Certificates, for fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Product Certificates for each type of domestic-water heater.
- D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- E. Source quality-control reports.

- F. Field quality-control reports.
- G. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Periods: From date of Substantial Completion.
 - a. Gas-Fired, Tankless, Domestic-Water Heaters:
 - 1) Heat Exchanger: Five years.
 - 2) Controls and Other Components: Three years.
 - b. Expansion Tanks: Five years.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Component Importance Factor: 1.5.
- C. ASHRAE/IES Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IES 90.1.
- D. ASME Compliance:
 1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
- E. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 GAS-FIRED, TANKLESS, DOMESTIC-WATER HEATERS

- A. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
- B. Standard: ANSI Z21.10.3/CSA 4.3 for gas-fired, instantaneous, domestic-water heaters for indoor application.
- C. Construction: Copper piping or tubing complying with NSF 61 and NSF 372 barrier materials for potable water, without storage capacity.
 1. Tappings: ASME B1.20.1 pipe thread.
 2. Pressure Rating: 150 psig.
 3. Heat Exchanger: Stainless steel.
 4. Insulation: Comply with ASHRAE/IES 90.1.
 5. Jacket: Metal, with enameled finish, or plastic.
 6. Burner: For use with tankless, domestic-water heaters and natural-gas fuel.
 7. Automatic Ignition: Manufacturer's proprietary system for automatic, gas ignition.
 8. Temperature Control: Adjustable thermostat.
- D. Support: Bracket for wall mounting.
- E. Capacity and Characteristics:
 1. Flow Rate: 11.6 at 100 deg F temperature rise.
 2. Temperature Setting: 140 deg F.
 3. Fuel Gas Input: 625 MBH.
 4. Gas Pressure Regulator:
 - a. Capacity: 625 MBH .
 - b. Inlet Pressure: 2 PSIG water column.

- c. Gas Pressure Required at Burner: 4" water column.
- 5. Electrical Characteristics:
 - a. Volts: 120 V.
 - b. Phase: Single.
 - c. Hertz: 60 Hz.
 - d. Full-Load Amperes: 20 A.
- 6. Minimum Vent Diameter: 4".

2.3 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:

- 1. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
- 2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
- 3. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
- 4. Capacity and Characteristics:
 - a. Working-Pressure Rating: 150 psig
 - b. Capacity Acceptable: 2 gal. minimum.
 - c. Air Precharge Pressure: 55 psig.

B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball, butterfly or gate-type shutoff valves to isolate each domestic-water heater and memory stop balancing valves to provide balanced flow through each domestic-water heater.

- F. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."
- G. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1, manually operated. Furnish for installation in piping.
- H. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 2-psig pressure rating as required to match gas supply.
- I. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- J. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.
 - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4.
- K. Pressure Relief Valves: Include pressure setting less than working-pressure rating of domestic-water heater.
 - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4.
- L. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
- M. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater minimum of 18 inches above the floor.
- N. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.
- C. Domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 2. Maintain manufacturer's recommended clearances.
 3. Arrange units so controls and devices that require servicing are accessible.
 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 8. Anchor domestic-water heaters to substrate.
- B. Tankless, Domestic-Water Heater Mounting: Install tankless, domestic-water heaters at least 18 inches above floor on wall bracket.
1. Maintain manufacturer's recommended clearances.
 2. Arrange units so controls and devices that require servicing are accessible.
 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 5. Anchor domestic-water heaters to substrate.
- C. Install domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping.
- D. Install gas-fired, domestic-water heaters in accordance with NFPA 54.
1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
 2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.

3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
- E. Install oil-fired, domestic-water heaters in accordance with NFPA 31.
 1. Install shutoff valves on fuel-oil supply piping to oil-fired water-heater burners without shutoff valves.
- F. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment".
- G. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- H. Install combination temperature-and- pressure relief valves in water piping for domestic-water heaters without storage. Extend domestic-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- I. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
- J. Install thermometer on outlet piping of domestic-water heaters.
- K. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet.
- L. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
- M. Fill domestic-water heaters with water.
- N. Charge domestic-water expansion tanks with air to required system pressure.
- O. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

- A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."
- B. Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Domestic-water heaters will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas-fired, tankless domestic-water heaters. Training shall be a minimum of two hours.

END OF SECTION

SECTION 224000 PLUMBING FIXTURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial Water closets.
2. Commercial Urinals.
3. Commercial Lavatories.
4. Commercial Sinks.
5. Commercial Showers.
6. Emergency Plumbing Fixtures.
7. Pressure Water Coolers.
8. Faucets.
9. Flushometer valves.
10. Toilet seats.
11. Supports.

1.2 DEFINITIONS

- A. Effective Flush Volume: Average of two reduced flushes and one full flush per fixture.
- B. Remote Water Closet: Located more than 30 feet from other drain line connections or fixture and where less than 1.5 drainage fixture units are upstream of the drain line connection.

1.3 ACTION SUBMITTALS

- A. Product Data for each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Sustainable Design Submittals:
- C. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and faucets to include in operation and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include servicing and adjustments of automatic faucets.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no less than one of each type.
 - 2. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 3. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 PRODUCTS

2.1 COMMERCIAL WATER CLOSETS

- A. Refer to Plumbing Fixture Schedule on Drawing P-000 for plumbing fixture specifications.

2.2 COMMERCIAL URINALS

- A. Refer to Plumbing Fixture Schedule on Drawing P-000 for plumbing fixture specifications.

2.3 COMMERCIAL LAVATORIES

- A. Refer to Plumbing Fixture Schedule on Drawing P-000 for plumbing fixture specifications.

2.4 COMMERCIAL SINKS

- A. Refer to Plumbing Fixture Schedule on Drawing P-000 for plumbing fixture specifications.

2.5 COMMERCIAL SHOWERS

- A. Refer to Plumbing Fixture Schedule on Drawing P-000 for plumbing fixture specifications.

2.6 EMERGENCY PLUMBING FIXTURES

- A. Refer to Plumbing Fixture Schedule on Drawing P-000 for plumbing fixture specifications.

2.7 PRESSURE WATER COOLERS

- A. Refer to Plumbing Fixture Schedule on Drawing P-000 for plumbing fixture specifications.

2.8 LAMINAR-FLOW, FAUCET-SPOUT OUTLETS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet-spout-outlet materials that will be in contact with potable water.
- B. Description: Chrome-plated-brass, faucet-spout outlet that produces non-aerating, laminar stream. Include external or internal thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

2.9 SUPPORTS

- A. Water Closet Carrier:
 - 1. Standard: ASME A112.6.1M.
 - 2. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space where applicable.
- B. Type II Lavatory Carrier: Standard: ASME A112.6.1M.
- C. Type III Lavatory Carrier: Standard: ASME A112.6.1M.

2.10 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.

- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.
- F. Risers:
 - 1. NPS 1/2.
 - 2. Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces riser.

2.11 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
- C. Trap:
 - 1. Size: NPS 1-1/2 by NPS 1-1/4.
 - 2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall and chrome-plated, brass or steel wall flange.
 - 3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where water closets and urinals will be installed.
- C. Examine counters and walls for suitable conditions where lavatories will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Water-Closet Installation:
 - 1. Install level and plumb according to roughing-in drawings.

2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:

1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
2. Use carrier supports with waste-fitting assembly and seal.
3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
5. Install supports, affixed to building substrate, for wall-hung urinals.
6. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
7. Use carriers without waste fitting for urinals with tubular waste piping.
8. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Install flushometer-valve water-supply fitting on each supply to each urinal.
3. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
4. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
5. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
6. Install actuators in locations that are easy for people with disabilities to reach.

D. Install toilet seats on water closets.

E. Install lavatories level and plumb according to roughing-in drawings.

F. Install supports, affixed to building substrate, for wall-mounted lavatories.

G. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.

H. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

- I. Joint Sealing:
 - 1. Seal joints between fixtures and counters and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 - 2. Match sealant color to fixture color.
 - 3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- J. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, and soil, waste, and vent piping. Use size fittings required to match fixture.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to fixtures, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust fixture and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at flushometer valves and faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. Clean fixtures and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed fixtures and fittings.
- C. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.
- D. After completing installation of fixtures, inspect and repair damaged finishes.

END OF SECTION

SECTION 230010 - BASIC MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section. The word drawings are inclusive of all drawings contained in the contract documents. Work pertaining to Division 23 may be contained in any drawing, any specification section, the General or the Supplementary Conditions. The presentation of requirements in separate specification sections, specification divisions, or individual drawing groupings (M, P, E, S, C, or A) is not intended to scope the work into separate subcontracts nor limit the work in any fashion. The contract documents work as a whole and the Contractor is required to provide all work (materials, equipment, and labor) as required to fully accomplish and make operational and complete all mechanical and plumbing work as reasonably inferable by any portion of the contract documents (drawings and specifications of all section). In case of conflict in quantities of work indicated between any drawing or specification the contractor is to provide the greatest number and/or amount of work, including providing all supporting infrastructure reasonably inferable.
- B. Where items under the Bidding and Contract Requirements, and Division 1 - General Requirements are repeated in this section, it is intended to call particular attention to or qualify the items. It is not intended that any other parts under the Bidding and Contract Requirements of Division 1 - General Requirements shall be assumed to be omitted if not repeated herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE (NON-INCLUSIVE)

- A. The work included under this Division shall include a complete mechanical system as shown on the drawings and as specified herein. Any apparatus, appliance, material or work not shown on the drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete in all respects and ready for operation, even if not particularly specified, shall be furnished, delivered and installed by the contractor without additional expense to the Owner.
- B. The contractor shall note that all items of equipment are specified in the singular; however, the contractor shall provide and install the number of items of equipment as indicated on the drawings and as required for a complete system.
- C. It is the intention of the specifications and drawings to call for finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean, "provide and install complete and ready for use."

- D. Minor details not usually shown or specified but necessary for proper installation and operations shall be included in the contractor's estimate, the same as if herein specified or shown.

1.3 APPLICABLE SPECIFICATIONS, CODES, STANDARDS AND PERMITS

- A. All equipment, materials and installation shall conform to the requirements of national, state and local codes, laws, ordinances, rules and regulations. All utility connections shall conform to the requirements of the local utilities.
- B. Unless otherwise specified herein or shown on the contract drawings, the work and materials shall conform to the applicable requirements of the following codes, standards and regulations using the latest editions in effect in the local jurisdiction:
 - 1. ICC International Code Council
 - 2. AMCA Air Movement and Control Association International, Inc
 - 3. AHRI Air Conditioning & Refrigeration Institute
 - 4. ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
 - 5. ASME American Society of Mechanical Engineers
 - 6. ASTM American Society of Testing Materials
 - 7. NEC National Electrical Code
 - 8. NFPA National Fire Protection Association
 - 9. OSHA Occupational Safety and Health Association
 - 10. SMACNA Sheet Metal and Air Conditioning Contractors National Association
 - 11. UL Underwriters Laboratories, Inc.
 - 12. ANSI American National Standards Institute
 - 13. AWS American Welding Society
 - 14. NEMA National Electrical Manufacturer's Association
 - 15. CISPI Cast Iron Soil Pipe Institute
 - 16. IRI Industrial Risk Insurers
 - 17. CAA Clean Air Act Amendment of 1990 (Title VI, Section 608)
 - 18. CTI Cooling Tower Institute
- C. Contractor shall give all necessary notices, obtain all permits and pay all Government taxes, fees and other costs, including costs for water, sewer, and gas connections or extensions including meters, in connection with his work, file all necessary plans, prepare all documents and obtain required certificates of inspection for work and deliver same to Owner before request for acceptance and final payment for work.
- D. The contractor shall be responsible for purchasing equipment and appliances that bear the label of an approved testing agency (UL, ETL, or others as deemed equivalent by the Engineer. It shall be the responsibility of the contractor to pay for any label testing of equipment or appliances that are installed without such label.

1.4 SUMMARY

- A. This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one section of Division 23. It expands and supplements the requirements specified in sections of Division 1.
1. Submittals.
 2. Coordination drawings.
 3. Record documents.
 4. Maintenance manuals.
 5. Rough-ins.
 6. Mechanical installations.
 7. Cutting and patching.
 8. Warranties
 9. Maintenance Contract
 10. Factory Start-up and Training
 11. Spare Filters with Peg Board
 12. Cutting and Patching
- B. Related Sections: The following sections contain requirements that relate to this section:
1. Division 23 Section "Electrical Requirements for Mechanical Equipment", for factory-installed motors, controllers, accessories, and connections.
 2. Division 23 Section "Basic Mechanical Materials and Methods", for materials and methods common to the remainder of Division 23, plus general related specifications.
 3. Division 23 Section "Commissioning", for the commissioning process of all mechanical equipment.

1.5 SUBMITTALS

- A. General: Follow the procedures specified in Division 1 Section "Submittals."
- B. Submittal Register: Provide a submittal register for all Division 21 through 27 work, including but not limited to: product data, shop drawings, certified data, and quality assurance reports. The submittal register shall be submitted with the first Division 21 through 27 submittal packages sent to for engineer review. **NO SUBMITTALS WILL BE RETURNED UNTIL A COMPLETE SUBMITTAL REGISTER IS ISSUED.**
- C. Equipment and material submittals shall be grouped together to allow review of groups of items whenever possible. All equipment and preconstruction submittals, with the exception of coordination drawings and controls, shall be submitted in no more than four groups. Submittals may be issued electronically (except for the Operation and Maintenance Manuals); however, a minimum of one hard copy shall be issued directly to the Engineer for the Engineer's record. Hard copy submittals shall be enclosed in hard back covers (preferably 3 ring binders) identifying the project and name and phone

number of the individual responsible for the submittal. First page of each submittal section shall have a blank area to receive the Architects/Engineer shop drawing stamp in addition to the area for the General Contractor's approval stamp.

- D. The contractor is responsible for complying with all contract requirements. Checking of submittals by the architect or engineer is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action indicated by the architect or engineer is subject to the requirements of the contract documents. Should the architect or engineer miss catching an error or feature in the submittal that does not comply with the contract requirements the Contractor remains responsible for meeting the requirements of the contract. The contractor is responsible for: dimensions which shall be confirmed and correlated at the job site; confirming and correlating all quantities; fabrication processes and techniques of construction; coordination of work between all trades; and the satisfactory performance of his work.
- E. Submittals marked "No Exception Taken" indicate that the architect or engineer has found no obvious deviations from the contract requirements and that the contractor may continue the procurement process subject to compliance with the contract requirements.
- F. Submittals marked "Make Corrections Noted" indicate that the architect or engineer has made corrective notations on the submittal in response to contract deviations that he has found and that the contractor may continue the procurement process subject to compliance with the notations and the contract requirements.
- G. Submittals marked "Revise and Resubmit" indicate that the architect or engineer has found significant deviations from the contract requirements and that the contractor must correct the submittal in accordance with the architect or engineer's notations and resubmit the submittal for review; however, the likelihood is that the submittal can be corrected to come into compliance with the contract requirements.
- H. Submittals marked "Rejected" indicate that the architect or engineer has found deviations from the contract requirements of such magnitude that the submitted cannot be made compliant with the contract requirements and will not be accepted for further consideration; that the contractor must prepare a new submittal using a different manufacturer, product, model, or process, as applicable, and in accordance with the contract requirements.
- I. Submittals marked "Submit Specified Item" indicate that the submittal is rejected and that only the item specified on the plans or in the specifications will be acceptable, and that the contractor must prepare a new submittal using the specified item.

1.6 COORDINATION DRAWINGS

- A. Quality Assurance:

1. Coordination Drawing Subcontractor: Employ the services of a third-party entity who is not providing any physical construction work and who specializes in coordination drawing preparation utilizing three-dimensional modeling techniques. The coordination drawing subcontractor shall have a minimum of five years of experience in providing this type of service using three-dimensional modeling. The coordination drawing subcontractor shall be directly contracted by the General Contractor. Electronic CAD files will be made available to the contractor if required. There will be a \$300 fee for producing the disk for this service and the contractor will be required to sign a release.
2. Submittals: Within 30 days of receipt of notice to proceed submit the following. No other Division 21 through 27 submittals shall be released until after submission of this material.
 - a. Coordination Drawing Subcontractor Qualifications: Provide a firm profile describing the experience of the company in providing these services along with three project examples (including a name and phone number for a reference for each project). Provide a resume for key staff who will work on the project.
 - b. Coordination Implementation Plan: Submit a narrative description of how the coordination drawing subcontractor will work with the general contractor and each trade subcontractor. The narrative shall explain how individual trade shop drawings will be developed in concert with the coordination drawings, how coordination between the trades shall be accomplished, and how coordination meetings will occur along with a schedule. Indicate how structural steel shop drawings will be developed to coordinate with actual equipment and system weights and openings, and how the structural steel and Division 21 through 27 shop drawings and the coordination drawings shall all coordinate. Discuss how the new building architectural elements shall be accurately modeled and coordinated. Discuss how site features, such as grades and site utilities shall be modeled and coordinated. Explain what software will be used for each of the individual trades to produce their shop drawings, what software shall be used for modeling of the coordination drawings, and what software shall be used for clash detection. Explain the proposed clash resolution process.
 - c. Shop Drawings: Submit color shop drawings along with the native electronic drawing file. Unless the native electronic file is AutoCAD, Revit, or Navisworks, submit two copies of the viewing software required for the Architect and Engineer to review the model in 3D, including panning, zooming, and rotating views.
3. Coordination Drawing Activity Kick-off Meeting: Prior to the development of any trade shop drawings conduct a field meeting to kick-off the coordination process. Schedule the kick-off meeting with the architect and engineer a minimum of seven days in advance. The meeting shall review the complete coordination drawing process. Key staff and the foremen for every major trade shall be in attendance. Division 21 through 27 work shall not start on any portion of the site or building

until Engineer's approval (or partial approval) of the associated coordination drawings for that portion of the work.

- B. Provide coordination drawings. Prepare coordination drawings in accordance with Division 1 Section "Project Coordination", to a scale of 1/4 inch = 1 foot - 0 inch or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Coordination drawings shall be prepared by a third-party organization specializing in coordination drawing preparation and utilizing three-dimensional modeling techniques to indicate the building structure, walls, ceilings, lights, ductwork, HVAC piping, plumbing piping 2" diameter and larger, fire sprinkler piping, mechanical and electrical equipment, conduits 2" diameter and larger, ductbanks, cable trays, and similar features. Coordination drawings shall indicate both above ground and below grade work, both interior of the building and exterior of the building (on-site). Individual system shop drawings shall be prepared in coordination with the coordination drawing preparation. Coordination drawings shall indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the proposed locations of piping, ductwork, equipment, and materials. The contractor shall organize each subsystem to fit within the allowable space and shall propose minor to moderate alternative locations and/or rerouting of systems to resolve spatial conflicts. These adjustments shall be clouded. Include the following in the coordination drawing package:
1. Clearances for installing and maintaining insulation.
 2. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
 3. Equipment connections and support details.
 4. Exterior wall and foundation penetrations.
 5. Fire-rated wall and floor penetrations.
 6. Sizes and location of required concrete pads and bases.
 7. Valve stem movement.
 8. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
 9. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 10. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.
 11. Prepare site utility drawings. Indicate all Division 2, 21 through 27 work. Detail every crossing of work with a site utility, including but not limited to: sanitary, storm, water, storm water retention, gas, transmission lines, etc...
- C. **NO DUCTWORK SHALL BE FABRICATED UNTIL THE CONTRACTOR HAS RECEIVED A COPY OF A SET OF COORDINATION DRAWINGS APPROVED BY THE MEP ENGINEER.**

1.7 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 1 Section "Project Closeout". In addition to the requirements specified in Division 1, indicate the following installed conditions:
1. Ductwork mains and branches, size, and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.
 2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.) Valve location diagrams, complete with valve tag chart. Refer to Division 23 Section "Mechanical Identification." Indicate actual inverts and horizontal locations of underground piping.
 3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 4. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
 5. Engage the services of a Land Surveyor or Professional Engineer registered in the state in which the project is located to record the locations and invert elevations of underground installations, including but not limited to: sanitary, storm, domestic water, fire water, HVAC piping, conduits and ductbanks.

1.8 MAINTENANCE MANUALS

- A. Prepare maintenance manuals in accordance with Division 1 Section "Project Closeout". In addition to the requirements specified in Division 1, include the following information for equipment items:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 4. Servicing instructions and lubrication charts and schedules.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.10 WARRANTIES

- A. All Division 23 equipment shall be provided with a factory warranty for all parts and labor with 24-hour service. The warranty shall expire 24 months from the date of Substantial Completion, as defined by the date of the Substantial Completion Certificate. This is not necessarily a 24-month warranty period, rather, early start-up of the equipment prior to the substantial completion date should be expected and shall not affect the expiration date. The contractor shall coordinate this aspect with his suppliers as required.
- B. Extended Warranties: Select pieces of equipment may be specified to have extended warranties which expire after the primary project warranty lists in the paragraph above. However, extended warranties shall also be coordinated with the date of substantial completion to expire in time periods relative to the substantial completion certificate.

1.11 MAINTENANCE CONTRACT: The contractor shall provide a one-year maintenance contract which shall include all labor and materials to perform all manufacturer recommended preventative maintenance, equipment cleaning, and repairs. The contractor shall provide a minimum of six inspections per year. The maintenance contract shall start upon the date of substantial completion as indicated on the substantial completion certificate.

1.12 FACTORY START-UP: Provide factory start-up on major pieces of equipment. Startup of all mechanical equipment shall be performed by a factory trained technician with at least 40 hours of factory training on said piece of equipment.

1.13 FACTORY TRAINING: Provide factory training on all equipment. Schedule training with at least 21 days' notice to the Owner and AE, by submitting a draft training schedule. Indicate all proposed training dates with specific equipment descriptions. The Contractor shall then confirm these dates with the Owner and AE, and after received approval of these dates shall submit a final training schedule at least 14 days prior to the agreed upon dates.

1.14 LEED CERTIFICATION:

- A. The project is required to obtain a LEED Gold certification. The contractor shall provide all required LEED documentation as required to achieve the LEED credits indicated in the contract.
- B. Refer to Section 01351 - Sustainable Project Requirements for additional requirements for sustainable design submittals.
- C. The project includes both LEED Fundamental and Enhanced Commissioning. Provide all services as required for compliance with the Fundamental and Enhanced

Commissioning requirements. Coordinate with the Commissioning Agent as required. Refer to the Commissioning specification sections for additional information.

- 1.15 **CHANGES IN WORK:** When additional work is requested by the Owner or Engineer the Contractor shall provide a proposed change order to include a complete description of the additional work, a detailed breakdown of materials and labor removed by the change to be credited, and a detailed breakdown of materials and labor to be added. The value of credited work and additional work shall be priced on the same basis. Materials, labor, and any other cost shall be based upon the current version of the RS Means Mechanical Cost Data book, RS Means Plumbing Cost Data book, or RS Means Electrical Cost Data book. Actual supplier pricing for materials may be submitted so long as the pricing is competitive (within 5%) with competing local or internet-based sources and a detailed breakdown is provided. Manufacturer material shipping and handling costs may apply; however, normal contractor overhead costs, including the cost of supervision, shop drawing production, ordering, and internal transit costs may not be charged separately and shall be included in the overhead costs. Unless defined in other locations of these contract documents, the maximum allowable combination of overhead and profit for the general contractor and all subcontractors (of all tiers) shall not exceed 25% of the sum of the material and labor costs.
- 1.16 **USE OF THE TERM COORDINATE:** Whenever the term coordinate is used in any location of the drawings or specifications is shall be defined to mean to field confirm the actual item being provided and to modify, adjust, and provide all materials and work to make the item completely functional in the manner intended. This includes providing all work reasonably inferable.
- 1.17 **PRECEDENCE OF CONTRACT DOCUMENTS OVER REFERENCED STANDARDS.** No provision of a Referenced Standard is effective to change (i) the procedures established in the Contract Documents or by any applicable laws or regulations, or (ii) the duties and responsibilities of the Owner, Architect/Engineer or Contractor from those set forth in the Contract Documents; nor is any provision of a Referenced Standard effective to assign to the Owner or the Architect/Engineer any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility inconsistent with any other provision of the Contract Documents.

PART 2 PRODUCTS

2.1 SPARE FILTERS

- A. Provide nine spare sets of filters for each piece of mechanical equipment requiring such.

- B. Spares are those items provided at the time the building is turned over to the Owner and is in addition to those filters originally provided with the equipment, and the new clean filters that the contractor installs in the equipment at substantial completion.
- C. Provide a detailed list of mechanical equipment with associated filter sizes and provide this information in the O & M Manual.

PART 3 EXECUTION

3.1 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 26 for rough-in requirements.

3.2 MECHANICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
 - A. Coordinate mechanical systems, equipment, and materials installation with other building components.
 - B. Verify all dimensions by field measurements.
 - C. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
 - D. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - F. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - G. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
 - H. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements

indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

- I. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- J. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
- K. Install access panel or doors where units are concealed behind finished surfaces.
- L. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
- M. Install mechanical systems, materials, and equipment and coordinate with all adjacent items so as to maintain the manufacturer's recommended service clearance requirements. Indicate service clearance requirements on the coordination shop drawings. Advise the Engineer of any service clearance conflicts prior to installation. Remove, relocate, and revise conflicting items that have already been installed without additional cost to the Owner.

3.3 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING". In addition to the requirements specified in Division 1, the following requirements apply:
 - 1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
 - 2. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
 - 3. Uncover work to provide for installation of ill-timed or uncoordinated work. Uncoordinated work shall be deemed any work that does not fit within the allowable space.
 - 4. Remove and replace defective work.
 - 5. Remove and replace work not conforming to requirements of the Contract Documents.
 - 6. Remove samples of installed work as specified for testing.
 - 7. Upon written instructions from the Architect, uncover and restore work to provide for Architect/Engineer observation of concealed work.
 - 8. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, insulation, tanks and other mechanical items made obsolete by the new work.

9. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
10. Provide core drilling and other cutting means and methods as necessary to relocate piping, conduit, and other mechanical-electrical features when required for ill-timed or uncoordinated work.
11. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
12. Patch newly finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.4 FOUNDATIONS AND SUPPORTS

- A. Contractor shall provide all necessary foundations, supports, pads and bases required for mechanical equipment and any other equipment furnished under this contract.
- B. For all floor mounted equipment inside of the building provide concrete housekeeping pads 4" in height (unless height noted otherwise) extending not less than 4" beyond equipment base in all directions. Equipment shall be installed with the appropriate vibration assembly.

END OF SECTION

SECTION 230030 - ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. This section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment.
- B. Specific electrical requirements (i.e., Horsepower and Electrical Characteristics) for mechanical equipment are scheduled on Mechanical Drawings.
- C. This section specifies minimum motor efficiencies for all motors on this project. Efficiencies shall be submitted for all motors regardless of whether they are part of a packaged unit or not. Equipment not meeting minimum motor efficiencies will be rejected.

1.2 REFERENCES

- A. NEMA Standards MG 1: Motors and Generators
- B. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and assemblies.
- C. NEMA Standard 250: Enclosures for Electrical Equipment
- D. NEMA Standard KS 1: Enclosed Switches
- E. Comply with National Electrical Code (NFPA 70.)

1.3 SUBMITTALS

- A. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections.
- B. Product Data: Submit manufacturer's technical product data including rated capacities of selected model clearly indicated; operating weights; furnished specialties and accessories; and installation, rigging, and start-up instructions.
- C. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, required clearances, and methods of assembly of components.

- D. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to equipment. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- E. Maintenance Data: Submit maintenance data and parts list for each item, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.
- F. Quality Assurance Reports: Submit a report for every quality assurance test.

1.4 QUALITY ASSURANCE

- A. Electrical components and materials shall be and bear the UL or ETL labeled.

PART 2 PRODUCTS

2.1 MOTORS

- A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.
 - 1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
 - 2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
 - 3. Temperature Rating: Rated for 40 deg. C environment with maximum 50 deg. C temperature rise for continuous duty at full load (Class A Insulation).
 - 4. Starting capability: frequency of starts as indicated by automatic control system, and not less than 5 evenly time spaced starts per hour for manually controlled motors.
 - 5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
 - 6. Motor construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
 - 7. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit specific application.
 - 8. Bearings:
 - a. Ball or roller bearings with inner and outer shaft seals.
 - b. Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
 - c. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.
 - d. For fractional horsepower, light duty motors, sleeve type bearings are permitted.

9. Enclosure Type:
 - a. Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
 - b. Guarded drip-proof motors where exposed to contact by employees or building occupants.
 - c. Weather protected Type I for outdoor use, Type II where not housed.
10. Overload protection: built-in thermal overload protection and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
11. Noise rating: "Quiet".
12. Efficiency: Provide "Premium" efficiency motors as per the required minimum efficiency of this label as scheduled in accordance with IEEE Standard 112, test method B. If efficiency not specified, motors shall have a higher efficiency than "energy efficient" motors listed in accordance with IEEE Standard 112, test method B.
13. Schedule, NEMA Premium, Motor efficiencies required.

H.P. PERCENT EFFICIENCY					
	OPEN DRIP PROOF		TOTALLY	ENCLOSED	FAN
HP	1800 RPM	3600 RPM	COOLED	1800 RPM	600 RPM
1	85.5	77.0	85.5		77.0
1.5	86.5	82.5	86.5		84.0
2	86.5	85.5	86.5		85.5
3	89.5	85.5	89.5		86.5
5	89.5	86.5	89.5		88.5
7.5	91.0	88.5	91.7		89.5
10	91.7	89.5	91.7		90.2
15	93.0	90.2	92.4		91.0
20	93.0	91.0	93.0		91.0
25	93.6	91.7	93.6		91.7
30	94.1	91.7	93.6		91.7
40	94.1	92.4	94.1		92.4
50	94.5	93.0	94.5		93.0
60	95.0	93.6	95.0		93.6
75	95.0	93.6	95.4		93.6
100	95.4	93.6	95.4		94.1
125	95.4	94.1	95.4		94.1
150	95.8	94.1	95.4		95.0

14. All equipment submittal shop drawings shall indicate motor efficiencies.
15. Nameplate: indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

- B. Variable Frequency Drive Applications: Motors which are paired with variable frequency drives shall be rated for such application.

2.2 STARTERS, ELECTRICAL DEVICES, AND WIRING

A. Motor Starter Characteristics

1. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs, or units in hazardous locations which shall have proper NEMA class and division.
2. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.

B. Manual switches shall have:

1. Pilot lights
2. Overload protection: melting alloy type thermal overload relays.

C. Magnetic Starters:

1. Hand-off-automatic switches and pilot lights, properly arranged for single speed or multi-speed operation as indicated for equipment to be manually energized/deenergized with no automatic control sequencing. Hand-off-automatic switch with indicator lights, properly arranged for single speed or multi-speed operation, as indicated for all equipment with automatic control sequences.
2. Trip-free thermal overload relays, each phase.
3. Interlocks and similar devices as required for coordination with control requirements of Division 23 Controls sections.
4. Built-in 120 volts control circuit transformer, fused from line side, where service exceeds 240 volts.
5. Externally operated manual reset.
6. Under-voltage release or protection.

D. Motor connections: Flexible metal conduit, except where plug-in electrical cords are specifically indicated. Liquid-tight flexible metal conduit shall be used in damp or wet locations.

E. Disconnect Switches:

1. Fusible switches: fused, each phase; heavy duty; horsepower rated; non-teasible quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "OPEN" position; arc quenchers; ground wire lug brazed to enclosure; capacity and characteristics as indicated.

2. Non-fusible switches: for equipment 2 horsepower and smaller, shall be horsepower rated; toggle switch type; quantity of poles and voltage rating as indicated. For equipment larger than 2 horsepower, switches shall be the same as fusible type.

2.3 CAPACITORS

A. Features:

1. Individual unit cells.
2. All welded steel housing.
3. Each capacitor internally fused.
4. Non-flammable synthetic liquid impregnant.
5. Craft tissue insulation.
6. Aluminum foil electrodes.
7. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 5 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load.

2.4 VARIABLE FREQUENCY DRIVES

- A. The VFD package as specified herein shall be enclosed in a UL Listed Type enclosure (enclosures with only NEMA ratings are not acceptable). Provide NEMA rating at least meeting the installed environment requirements, including (but not limited to) as a minimum: NEMA 1 for standard indoor environments, and NEMA 3R for exterior applications.
- B. Environmental operating conditions: 0 to 400 C (32 to 1040 F) continuous. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing. All circuit boards shall have conformal coating.
- C. Enclosure shall be UL rated and shall be UL listed as a plenum rated VFD.
- D. All VFDs shall have the following standard features:
- E. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
- F. The keypad shall include Hand-Off-Auto selections and manual speed control. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
- G. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients.

- H. The input current rating of the VFD shall be no more than 3% greater than the output current rating. VFD's with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.120.
- I. The VFD shall provide a programmable loss-of-load (broken belt / broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and / or over the serial communications bus.
- J. All VFDs to have the following adjustments:
 - 1. Run permissive circuit - There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad command, input contact closure, time-clock control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. A minimum of two separate safety interlock inputs shall be provided. When any safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close.
 - 2. The VFD shall include a fireman's override input. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlocks, and force the motor to run at a preset speed or in a separate PID mode.
- K. Serial Communications:
 - 1. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet MS/TP. The use of third-party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e., BTL Listing for BACnet).
 - 2. EMI / RFI filters. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the entire VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted. No Exceptions.
- L. Optional Features – Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.
- M. Bypass Controller
 - 1. A complete factory wired and tested bypass system consisting of a door interlocked, padlockable circuit breaker, output contactor, bypass contactor, and fast acting VFD isolation fuses.

2. The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the “Off” position before either enclosure may be accessed.
 3. The VFD and bypass package shall have a UL listed short circuit current rating (SCCR) of 100,000 amps and this rating shall be indicated on the UL data label.
 4. The drive and bypass package shall be seismic certified and labeled to the IBC:
 - a. Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake test data as defined by ICC AC-156.
- N. Drive Isolation Fuses - To ensure maximum possible bypass operation, fast acting fuses, exclusive to the VFD, shall be provided to allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection. This maintains bypass operation capability in the event of a VFD failure. Bypass designs, which have no such fuses will not be accepted.
- O. The system (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30%, -35% nominal voltage range. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain “sealed in” over this voltage tolerance at a minimum.
- P. The bypass shall maintain positive contactor control throughout the voltage tolerance window of nominal voltage +30%, -35%. This feature is designed to avoid contactor coil failure during brown out / low line conditions and allow for input single phase operation when in the VFD mode. Designs that will not allow input single phase operation in the VFD mode are not acceptable.
- Q. Motor protection from single phase power conditions - the bypass system must be able to detect a single-phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single-phase input power indication. Bypass systems not incorporating single phase protection in bypass mode are not acceptable.
- R. The bypass system shall NOT depend on the VFD for bypass operation. The bypass system shall be designed for stand alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair / replacement. Serial communications shall remain functional even with the VFD removed.
- S. Serial communications – the bypass shall be capable of being monitored and / or controlled via serial communications. On-board communications protocols shall include ModBus, Johnson Controls N2, Siemens Building Technologies FLN (P1), and BACnet MS/TP.
- T. The user shall be able to select the text to be displayed on the keypad when an external safety opens. Example text display indications include “Smoke Detector”, “FreezStat”, “Over pressure” and “Low suction”. The user shall also be able to determine which of the up to four (4) customer safety contacts is open over the serial communications connection.

- U. Phase Monitor: provide external ICM 450 phase monitors with display to protect equipment when VFD is in by-pass mode.
- V. Provide all three-phase equipment with ICM model 450 phase monitors with display with automatic restart.
- W. Identification: Label all VFD's with location and room number of associated pieces of equipment.
- X. Manufacturers: Subject to compliance with requirements, available manufacturers for variable frequency drives include the following:
 - 1. ABB.
 - 2. Trane.
 - 3. Yaskawa.

PART 3 EXECUTION

- 3.1 **INSTALLATION:** Per NEMA ICS 3.1, install equipment in accordance with the approved manufacturer's printed installation drawings, instructions, wiring diagrams, and as indicated on project drawings and the approved shop drawings.
- 3.2 **FIELD QUALITY CONTROL:**
 - A. Specified products shall be tested as a system for conformance to specification requirements prior to scheduling the acceptance tests. Contractor shall conduct performance verification tests in the presence of the Owner's representative, observing and documenting complete compliance of the system to the specifications. Contractor shall submit a signed copy of the test results, certifying proper system operation before scheduling tests.
 - B. VFD Test: A proposed test plan shall be submitted to the commissioning agent at least 28 calendar days prior to proposed testing for approval. The tests shall conform to NEMA ICS 1, NEMA ICS 7, and all manufacturer's safety regulations. The Owner reserves the right to witness all tests and review any documentation. The contractor shall inform the Owner, Commissioning Agent, and Architect at least 14 working days prior to the dates of testing. All training aids, texts, and expendable support material for a self-sufficient presentation shall be provided, the amount of which to be determined by the Owner's representative.
 - C. Performance Verification Tests: "Performance Verification Test" plan shall provide the step-by-step procedure required to establish formal verification of the performance of the VFD. Compliance with the specification requirements shall be verified by inspections, review of critical data, demonstrations, and tests. The Owner reserves the right to witness all tests, review data, and request other such additional inspections and repeat tests as necessary to ensure that the system and provided services conform to the stated

requirements. The contractor shall inform the Owner 14 calendar days prior to the date the test is to be conducted.

- 3.3 PHASE MONITORS: Provide a phase monitor on each three-phase piece of equipment. Phase monitors shall be provided on three phase VFD's and shall be installed such that they protect the VFD in both normal and by-pass operation modes.
- 3.4 VARIABLE FREQUENCY DRIVES:
- A. Provide ICM 450 Phase monitors on all variable frequency drives installed per the manufacturer's installation instructions. Coordinate the settings on the phase monitor such that the phase monitor will deenergize the VFD before the VFD internal safety controls shut down the VFD, and keep the VFD de-energized for a sufficient time period to wait for rapid repetitive power loss/restoration cycles to cease to avoid the VFD from locking out due to rapid restart attempts. Phase monitors shall be installed such that they protect the VFD in both normal and by-pass operation modes.
 - B. Provide interlock wiring between equipment local disconnect switches and VFD's whenever the VFD is not within site of the equipment. The control interlock shall shut down the VFD if the service disconnect switch is switched off.
 - C. Provide a label inside each VFD that describes the physical location of each remote input device (sensor); with a description and room number.
 - D. Provide a label on each control input device serving a VFD with the VFD tag number and location (with room number).
- 3.5 START UP SERVICE: The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system.
- 3.6 CLOSEOUT PROCEDURES, VARIABLE FREQUENCY DRIVES
- A. Provide services of manufacturer's technical representative to instruct Owner's personnel in operation and maintenance of variable frequency drives.
 - B. Schedule training with Owner, provide at least 14-day notice to Commissioning Agent and Architect of training date.
 - C. Coordinate training requirements with the Owner's Representative and Commissioning Agent.

- D. Instructions to Owner's Personnel: Provide the services of competent instructors who will give full instruction to designated personnel in operation, maintenance, calibration, configuration, and programming of the complete control system. Orient the training specifically to the system installed. Instructors shall be thoroughly familiar with the subject matter they are to teach. The Owner personnel designated to attend the training will have a high school education or equivalent. The number of training days of instruction furnished shall be as specified. A training day is defined as eight hours of instruction, including two 15-minute breaks and excluding lunch time; Monday through Friday. Provide a training manual for each student at each training phase which describes in detail the material included in each training program. Provide one additional copy for archiving. Provide equipment and materials required for classroom training. Provide a list of additional related courses, and offers, noting any courses recommended. List each training course individually by name, including duration, approximate cost per person, and location of course. Unused copies of training manuals shall be turned over to the Owner at the end of last training session.
- E. Operating Personnel Training Program: Provide one 2-hour training session at the site at a time and place mutually agreeable between the Contractor and the Owner. Provide session to train 4 operation personnel in the functional operations of the system and the procedures that personnel will follow in system operation. This training shall include:
1. System overview
 2. General theory of operation
 3. System operation
 4. Alarm formats
 5. Failure recovery procedures
 6. Troubleshooting
- F. Engineering/Maintenance Personnel Training: Accomplish the training program as specified. Training shall be conducted on site at a location designated by the Owner. Provide a one day training session to train 4 engineering personnel in the functional operations of the system. This training shall include:
1. System overview
 2. General theory of operation
 3. System operation
 4. System configuration
 5. Alarm formats
 6. Failure recovery procedures
 7. Troubleshooting and repair
 8. Maintenance and calibration
 9. System programming and configuration

END OF SECTION

SECTION 230050 BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements specified in Division 23 Section "Basic Mechanical Requirements" apply to this Section.

1.2 SUMMARY

- A. This Section includes limited scope general construction materials and methods for application with mechanical installations as follows:
 - 1. Mechanical equipment nameplate data.
 - 2. Miscellaneous metals for support of mechanical materials and equipment.
 - 3. Prime painting of miscellaneous metals and pipe hangers.
 - 4. Joint sealers for sealing penetrations in all walls and floors, including regular walls, fire and smoke barriers, floors, and foundation walls.
 - 5. Access panels and doors in walls, ceilings, and floors for access to mechanical materials and equipment for service and maintenance.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 2 Section "Earthwork" for excavation and backfill requirements.
 - 2. Division 6 Section "Rough Carpentry" for materials and methods for wood grounds, nailers, blocking, fasteners and anchorage required to support Division 23 materials and equipment.

1.3 QUALITY CONTROL

- A. Installer Qualifications: Engage an experienced Installer for the installation and/or application joint sealers, access panels, and doors.
- B. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
- C. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.4 SEQUENCE AND SCHEDULING

- A. Coordinate the shut-off and disconnection of utility services with the Department and the utility company.

1.5 SUBMITTALS

- A. Material Safety Data Sheets (MSDS) for all applicable products to owner.

PART 2 PRODUCTS

2.1 MECHANICAL EQUIPMENT NAMEPLATE DATA

- A. Nameplate: For each piece of power operated mechanical equipment provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location. Where equipment is covered with insulation, the name plate shall be located outside boundaries of insulation.

2.2 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Non-shrink, Nonmetallic Grout: Premixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout, recommended for interior and exterior applications.
- F. Fasteners: Zinc-coated, type, grade, and class as required.

2.3 JOINT SEALERS

- A. All penetrations of building assemblies (walls, partitions, floors, slabs, etc..) shall be sealed closed around the penetrating item and the building element. The sealant shall generally be installed from both sides of the assembly when both sides are accessible during construction. IN all applications sealants shall be installed in such a manner to resist the passage of smoke and sound.

- B. Fire Rated Assemblies: All penetrations of fire rated assemblies shall be sealed with a labeled firesafe material selected to maintain the specified fire rating of the assembly and installed in accordance with the manufacturer's installation instructions for the specific fire rating required. Provide all required components indicated in the manufacturer's installation instructions as required to achieve the specified fire rating, including but not limited to: sleeves, supports, flanges, and additional insulation as may be required.
- C. Fire-Resistant Joint Sealers: Refer to Division 7 Section "Through-Penetration Firestop Systems" for additional requirements for fire stopping to be furnished and installed by Division 23.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILLING

- A. Perform excavation and backfilling, operations in accordance with Division 2 Section "Earthwork."

3.2 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.3 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.4 APPLICATION OF JOINT SEALERS

- A. Install sealant, including forming, packing, and other accessory materials, to fill openings around mechanical services penetrating all floors and walls. Installation shall provide fire-stops with fire-resistance ratings at least equal to that indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

END OF SECTION

SECTION 230055 - BASIC PIPING MATERIALS AND METHODS

PART 1 GENERAL

1.1 SUMMARY

- A. This Section specifies piping materials and installation methods common to more than one section of Division 23 and includes joining materials, piping specialties, and basic piping installation instructions.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 2 and other Division 23 sections for individual piping systems and the piping materials and installation methods peculiar to them.
 - 2. Division 230100 Section "Valves" and other Division 23 sections for individual piping systems for related valve materials and installation methods.
 - 3. Division 230510 Section "Hydronic Piping."
 - 4. Division 230529 Section "Supports and Anchors."
 - 5. Division 230190 Section "Mechanical Identification."

1.2 SUBMITTALS

- A. Refer to Division 1 and Basic Mechanical Requirements for administrative and procedural requirements for submittals.
- B. Product Data: Submit manufacturer's specifications for items showing dimensions, capacities, ratings, performance characteristics, gauges and finishes of materials and installation instructions.
- C. Reports: Submit a written report for each quality control test indicating all data. When applicable include the signature of the commissioning agent or inspection authority.
- D. LEED Information: Product data for Credit EQ 4.2: For field-applied paints and coatings, documentation including printed statement of VOC content in g/L.
- E. Material Safety Data Sheets (MSDS) for all applicable products to Howard County Environmental Health and Safety Office.

1.3 QUALITY CONTROL

- A. Safety Codes: Comply with all safety codes which govern the installations of welded piping.
- B. Welder's Qualifications: All welders shall be qualified in accordance with ANSI Code B31.1 for Power Piping and ANSI Code B31.9 for Building Service Piping.

- C. Welding procedures and testing shall comply with ANSI Code B31.1 - Standard Code for Power Piping, and The American Welding Society, Welding Handbook and ANSI Code B31.9 - Standard Code for Building Service Piping.
- D. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Mechanical Refrigeration.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.
- C. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide piping materials and specialties from one of the following:
 - 1. Pipe Escutcheons:
 - a. Chicago Specialty Mfg. Co.
 - b. Sanitary-Dash Mfg. Co.
 - c. Grinnell
 - B. Dielectric Waterway Fittings:
 - 1. Epcos Sales, Inc.
 - 2. Victaulic Company of America
 - C. Strainers:
 - 1. Armstrong Machine Works.
 - 2. Hoffman Specialty ITT; Fluid Handling Div.
 - 3. Metraflex Co.
 - 4. R-P&C Valve; Div. White Consolidated Industries, Inc.
 - 5. Trane Co.
 - 6. Watts Regulator Co.

- D. Mechanical Sleeve Seals: Thunderline Corp.

2.2 PIPE AND FITTINGS

- A. Refer to the individual piping system specification sections in Division 23 for specifications on piping and fittings relative to that particular system.

2.3 JOINING MATERIALS

- A. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
- B. Brazing Materials: Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.
- C. Soldering Materials: Refer to individual piping system specifications for solder appropriate for each respective system.
- D. Gaskets for Flanged Joints: Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.
- E. Grooved Ends, 2-1/2 Inch and Larger: Tee pattern, ductile-iron or malleable-iron body and access end cap, access coupling with EDPM gasket.

2.4 PIPING SPECIALTIES

- A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.
- B. Unions: Malleable-iron, Class 150 for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
- C. Dielectric Nipples (Dielectric Waterway Fittings): Provide dielectric nipples with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged). Electroplated steel or brass nipple, with an inert and non-corrosive, thermoplastic lining which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

- D. Y-Type Strainers: Provide strainers full line size of connecting piping, with ends matching piping system materials. Screens shall be Type 304 stainless steel, with 3/64-inch perforations at 233 per square inch.
- E. Provide strainers with 125 psi working pressure rating for low pressure applications, and 250 psi pressure rating for high pressure application.
- F. Threaded Ends, 2 Inch and Smaller: Cast-iron body screwed screen retainer with centered blowdown fitted with pipe plug.
- G. Threaded Ends, 2-1/2 Inch and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.
- H. Flanged Ends, 2-1/2 Inch and Larger: Cast-iron body bolted screen retainer with off-center blowdown fitted with pipe plug.
- I. Butt Welded Ends, 2-1/2 Inch and Larger for Low Pressure Application: Schedule 40 cast carbon steel body, bolted screen retainer with off-center blowdown fitted with pipe plug.
- J. Grooved Ends, 2-1/2 Inch and Larger: Tee pattern, ductile-iron or malleable-iron body and access end cap, access coupling with EDPM gasket.
- K. Sleeves:
 - 1. Sheet-Metal Sleeves: 10-gauge, galvanized sheet metal, round tube closed with welded longitudinal joint, for sleeves 6 inches and larger.
 - 2. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A53, Grade A, for sleeves 4 inches and smaller.
 - 3. Mechanical Sleeve Seals: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.2 INSTALLATIONS

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
- B. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.
- C. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.
- E. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- F. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- G. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch hose adapter with cap.
- H. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls above and below grade using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6 inches shall be steel; pipe sleeves 6 inches and larger shall be sheet metal.
- I. Interior Wall Penetrations: Seal pipe penetrations through interior walls using sleeves and approved sealants. Provide escutcheon cover on all visible wall penetrations. Pipe sleeves smaller than 6 inches shall be steel; pipe sleeves 6 inches and larger shall be sheet metal.
- J. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained by special listed sealers and materials installed per the manufacturer's installation requirements so as to maintain the assembly's fire rating.
- K. Wall and slab penetrations: Where pipes pass through non-fire rated walls, partitions, ceilings, or floors, the openings shall be sealed by approved sealers and materials for smoke, acoustic, and water protection.
- L. Provide sleeves for all penetrations through floor slabs and extend sleeves two inches higher than the finished floor elevation.

3.3 FITTINGS AND SPECIALTIES

- A. Use fittings for all changes in direction and all branch connections.
- B. Remake leaking joints using new materials.
- C. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, and elsewhere as indicated. Install blowdown valve on strainer outlet.
- D. Install unions adjacent to each valve, and at the final connection to each piece of equipment and plumbing fixture having 2 inch and smaller connections, and elsewhere as indicated.
- E. Install Flanges in piping 2-1/2 inch and larger, where indicated, adjacent to each valve, and at the final connection to each piece of equipment.
- F. Install dielectric fittings to connect piping materials of dissimilar metals in wet piping systems (water).

3.4 JOINTS

- A. Steel Pipe Joints:
 - 1. Pipe 2 Inch and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.
- B. Pipe Larger Than 2 Inches:
 - 1. Weld pipe joints (except for exterior water service pipe) in accordance with ANSI Code B31.1 for Power Piping and ANSI Code B31.9 for Building Service Piping.
 - 2. Weld pipe joints of exterior water service pipe in accordance with AWWA C206.
 - 3. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ANSI Code B31.1 for Pressure Piping and ANSI Code B31.9 for Building Service Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.
- C. Non-ferrous Pipe Joints:
 - 1. Brazed and Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI Code B31.1 - Standard Code for Power Piping, ANSI Code B31.9 - Standard Code for Building Service Piping and ANSI Code B9.1 - Standard Safety Code for Mechanical Refrigeration.

2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.
3. Mechanical Joints: Flared compression fittings may be used for refrigerant lines 3/4 inch and smaller.
4. Joints for other piping materials are specified within the respective piping system sections.

3.5 FIELD QUALITY CONTROL

- A. Testing: Refer to individual piping system specification sections.

END OF SECTION

SECTION 230100 - VALVES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes general duty valves common to most mechanical piping systems. Special purpose valves are specified in individual piping system specifications.
- B. Valve tags and charts are specified in Division 230190 Section "MECHANICAL IDENTIFICATION."

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.
- C. Certification of compliance with House Bill 372 for lead free materials for all valves in potable water systems.

1.3 QUALITY CONTROL

- A. Single Source Responsibility: Comply with the requirements specified in Division 1 Section "MATERIALS AND EQUIPMENT", under "Source Limitations."
- B. American Society of Mechanical Engineers (ASME) Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.
- C. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the various MSS Standard Practices referenced.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves for shipping as follows:
 - 1. Ensure valves are dry and internally protected against rust and corrosion.
 - 2. Protect valve ends against damage to threads, flange faces, and weld-end preps.

3. Set valves in best position for handling. Set globe and gate valves closed to prevent rattling; set ball and plug valves open to minimize exposure of functional surfaces and block swing check valves in either closed or open position.
- B. Storage: Use the following precautions during storage:
1. Do not remove valve end protectors unless necessary for inspection; then reinstall for storage.
 2. Protect valves from weather. Store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement in watertight enclosures.
- C. Handling: Use a sling to handle valves whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All components in potable water streams shall comply with House Bill 372 for lead free materials.

2.2 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products from one of the manufacturers listed below:
1. Crane
 2. Conbraco Industries, Inc.; Apollo Div.
 3. Grinnell
 4. Hammond
 5. Jamesbury, Inc
 6. Kitz Corporation of America
 7. Lunkenheimer
 8. Milwaukee
 9. NIBCO INC.
 10. Red-White Valve Corp.

2.3 VALVE FEATURES, GENERAL

- A. Valve Design: Rising stem or rising outside screw and yoke stems.
- B. Non-rising stem valves may be used where headroom prevents full extension of rising stems.

- C. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.
- D. Sizes: Same size as upstream pipe, unless otherwise indicated.
- E. Operators: Provide the following special operator features:
- F. Handwheels, fastened to valve stem, for valves other than quarter turn.
- G. Lever handles, on quarter-turn valves 6 inch and smaller, except for plug valves. Provide plug valves with square heads; provide one wrench for every 10 plug valves.
- H. Chain-wheel operators, for valves installed overhead with bottom greater than 8'-0" above the finished floor and for valves as indicated on Drawings. Extend chains to an elevation of 5 feet - 0 inch above finished floor elevation.
- I. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation and protect the piping insulation from ware and tare.
- J. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.
- K. End Connections: As indicated in the valve specifications.
- L. Threads: Comply with ANSI B1.20.1.
- M. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
- N. Solder-Joint: Comply with ANSI B16.18.
- O. Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F for gate, globe, and check valves; below 421 deg F for ball valves.

2.4 BALL VALVES

- A. Service Applications for Following Valve: All HVAC systems for isolation service.
- B. Ball Valves, 1 Inch and Smaller: Rated for 400 psi WOG pressure; two-piece construction; with bronze body conforming to ASTM B 62, full port, chrome-plated brass ball, replaceable "Teflon" or "TFE" seats and seals, blowout-proof stem, and vinyl-covered steel handle.
- C. Ball Valves, 1-1/4 Inch and larger: Rated for 400 psi WOG pressure; 3-piece construction; with bronze body conforming to ASTM B 62, full port, chrome-plated brass ball, replaceable "Teflon" or "TFE" seats and seals, blowout proof stem, and vinyl-covered steel handle.

2.5 GLOBE VALVES

- A. Service Applications for Following Class 150 Valves: domestic hot and cold water. Service applications for following class 150 valves:
- B. Globe Valves, 2 Inch and Smaller: MSS SP-80; Class 150; body and screwed bonnet of ASTM B 62 cast bronze; with threaded or solder ends, brass or replaceable composition disc, copper-silicon alloy stem, brass packing gland, "Teflon" impregnated packing, and malleable iron handwheel. Provide Class 150 valves meeting the above where system pressure requires.
- C. Globe Valves, 2-1/2 Inch and Larger: MSS SP-85; Class 150 iron body and bolted bonnet conforming to ASTM A 126, Class B; with outside screw and yoke, bronze mounted, "Teflon" impregnated packing, and two-piece backing gland assembly.

2.6 CHECK VALVES

- A. Swing Check Valves, 2 Inch and Smaller: MSS SP-80; Class 125, cast-bronze body and cap conforming to ASTM B 62; with horizontal swing, Y-pattern, and bronze. Provide valves capable of being reground while the valve remains in the line.
- B. Swing Check Valves, 2-1/2 Inch and Larger: MSS SP-71; Class 125 (Class 175 FM approved for fire protection piping systems), cast iron body and bolted cap conforming to ASTM A 126, Class B; horizontal swing, and bronze disc or cast-iron disc with bronze disc ring; and flanged ends. Provide valves capable of being refitted while the valve remains in the line.
- C. Wafer Check Valves: Class 250, cast-iron body; with replaceable bronze seat, and non-slam design lapped and balanced twin bronze flappers and stainless-steel trim and torsion spring. Provide valves designed to open and close at approximately one-foot differential pressure. Install water check at the discharge of all water pumps.
- D. Lift Check Valves, 2 Inch and Smaller: Class 125; cast-bronze body and cap conforming to ASTM B 62; horizontal or angle pattern, lift-type valve, with stainless steel spring, bronze disc holder with renewable "Teflon" disc, and threaded ends. Provide valves capable of being refitted and ground while the valve remains in the line.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine valve interior through the end ports for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks used to prevent disc movement during shipping and handling.

- B. Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides and seats made accessible by such actuation. Following examination, return the valve closure member to the shipping position.
- C. Examine threads on both the valve and the mating pipe for form (i.e., out-of-round or local indentation) and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
- E. Prior to valve installation, examine the piping for cleanliness, freedom from foreign materials, and proper alignment.
- F. Replace defective valves with new valves.

3.2 VALVE ENDS SELECTION

- A. Select valves with the following ends or types of pipe/tube connections:
 - 1. Copper Tube Size, 2 Inch and Smaller: Solder ends, except provide threaded ends for heating hot water and cold temperature water service.
 - 2. Steel Pipe Sizes, 2 Inch and Smaller: threaded end.
 - 3. Steel Pipe Sizes 2-1/2 Inch and Larger: flanged.

3.3 VALVE INSTALLATIONS

- A. General Application: Use gate and ball valves for shut-off duty; globe, and ball for throttling duty. Refer to piping system specification sections for specific valve applications and arrangements.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.
- D. Install three-valve bypass around each pressure reducing valve using throttling-type valves.
- E. Install valves in horizontal piping with stem at or above the center of the pipe.
- F. Install valves in a position to allow full stem movement.
- G. Installation of Check Valves: Install for proper direction of flow as follows:
 - 1. Swing Check Valves: Horizontal position with hinge pin level.

2. Wafer Check Valves: Horizontal or vertical position, between flanges.
3. Lift Check Valve: With stem upright and plumb.

3.4 SOLDER CONNECTIONS

- A. Cut tube square and to exact lengths.
- B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket in same manner.
- C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.
- D. Open gate and globe valves to fully open position.
- E. Remove the cap and disc holder of swing check valves having composition discs.
- F. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.
- G. Apply heat evenly to outside of valve around joint until solder will melt upon contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

3.5 THREADED CONNECTIONS

- A. Note the internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
- B. Align threads at point of assembly.
- C. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
- D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.6 FLANGED CONNECTIONS

- A. Align flange surfaces parallel.
- B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.7 FIELD QUALITY CONTROL

- A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

3.8 ADJUSTING AND CLEANING

- A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

END OF SECTION

SECTION 230190 - MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

- A. Extent of mechanical identification work required by this section is indicated on drawings and/or specified in other Division 23 sections.
- B. Types of identification devices specified in this section include the following:
 - 1. Engrave plastic laminate labels.
 - 2. Plastic Pipe Markers.
 - 3. Color Coded Piping Jackets
 - 4. Underground-Type Plastic Line Marker.
 - 5. Plastic Duct Markers.
 - 6. Valve Tags.
 - 7. Valve Schedule Holders
 - 8. Ceiling Markers
- C. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Other Division 230190 sections for mechanical identification furnished as part of factory-fabricated equipment assembly.
 - 2. Section 230250, Mechanical Insulation, for PVC jacketing of piping and equipment installed in all mechanical/utility rooms, and in all exposed locations. Colors of jacketing are specified in this section; match the colors of the plastic duct markers.
 - 3. Division 260195 sections for identification requirements of electrical work; not work of this Section.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.
- C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2 x 11" bond paper. Tabulate valve number, piping system, system abbreviation as shown on tag, location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.

- D. Maintenance Data: Include product data and schedules in maintenance manuals; in accordance with requirements of Division 1.
- E. Quality Assurance Reports: Submit a report for every quality assurance test.
- F. LEED Information: Product data for Credit EQ 4.1: For field-applied adhesives and sealants, documentation including printed statement of VOC content in g/L.
- G. Material Safety Data Sheets (MSDS) for all applicable products to County Environmental Health and Safety Office.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide mechanical identification materials of one of the following:
 - 1. Allen Systems, Inc.
 - 2. Brady (W.H.) Co.; Signmark Div.
 - 3. Industrial Safety Supply Co., Inc.
 - 4. Johns Manville
 - 5. Seton Name Plate Corp.

2.2 MECHANICAL IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than single type is specified for application, selections is Installer's option, but provide single selection for each product category.

2.3 ENGRAVED PLASTIC LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with the engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for fastening except where adhesive mounting is necessary because of substrate.

- B. Thickness: 1/16" for units up to 20 square inches or 8 inches in length; 1/8" for larger units.
- C. Fasteners: Self-tapping stainless-steel screws, except contact type permanent adhesive where screws cannot or should not penetrate the substrate.

2.4 CEILING MARKER

- A. Engraved plastic laminate sign screwed on ceiling grid or ceiling access door to indicate location. Comply with requirements for engrave plastic laminate signs.

2.5 PLASTIC PIPE MARKERS

- A. Pressure-Sensitive Type: Provide manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1.
- B. Pipes: For external diameters less than 6 inch (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - 1. Adhesive lap joint in pipe marker overlap.
 - 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inch.
- C. Lettering: Comply with piping system nomenclature as specified, scheduled or shown on the drawings, and abbreviate only as necessary for each application length.
- D. Color Coding: Obtain and conform to Prince George County Public Schools color code. Coordinate the color coding of the pipe markers with that of the plastic pipe covers to be provided in all major mechanical rooms and locations indicated on the drawings.
- E. Arrows: Provide each pipe marker with printed arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.6 COLOR CODED PIPING JACKETS

- A. 30 mil PVC roll jacketing cut and curled for straight pipe and preformed covers for fittings fabricated to fit snugly over piping insulation. This jacketing is provided in addition to the all-service jacket and vapor barrier of the piping insulation. PVC material shall be listed for contact with surface temperatures up to 150 degrees F. Flame spread of 25 or less, and smoke developed rating of 50 or less. Glossy finish. ASTM D1784, Class 16354-C compliant. Electrically non-conducting. Basis of Design: Johns Manville Zeston PVC Jacketing.

B. Color Code:

1. Heating Water: Purple
2. Chilled Water: Blue
3. Condensate (cold – from cooling coils): Grey
4. Make-up Water: Black
5. Refrigerant Suction: White
6. Domestic Hot Water: Orange
7. Domestic Cold Water: Light Blue

2.7 PLASTIC DUCT MARKERS

- A. General: Provide manufacturer's standard laminated plastic, color coded duct markers. Obtain and conform to Prince George County Public Schools color code.
- B. Nomenclature: Include the following:
1. Direction of air flow.
 2. Direction of water flow.
 3. Duct service (supply, return, exhaust, etc.).
 4. Water service (Hot water supply, Hot water return, cold water, etc.).

2.8 UNDERGROUND-TYPE PLASTIC LINE MARKERS

- A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6-inch-wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe. Provide multiply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

2.9 VALVE TAGS

- A. Plastic Valve Tags: Provide manufacturer's standard solid plastic valve tags with printed enamel lettering, with piping system abbreviation in approximately 3/16-inch-high letters and sequenced valve numbers approximately 3/8 inch high, and with 5/32-inch hole for fastener. Provide 1-1/8-inch sq. white tags with black lettering.
- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

2.10 VALVE SCHEDULE HOLDERS

- A. For each page of valve schedule, provide flexible plastic envelopes with reinforced three-ring punch holes.

- B. Provide a picture frame style frame with Plexiglas cover.

2.11 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
- B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

2.12 PAINT

- A. Anti-Corrosive Epoxy Primer: Corrosion-resistant, solvent-based, two-component epoxy primer formulated for use on prepared, interior ferrous- and galvanized-metal surfaces.
- B. Anti-Corrosion Epoxy Top Coat: Semi-gloss finish.

2.13 COLOR CODE

- A. Provide identification products using the following color coding. Division 21 and 22 systems are also listed herein for coordination purposes.

COLOR CODING				
SYSTEM	PIPE OR JACKET		MARKERS	
	COLOR	MATERIAL	FIELD	TEXT
Heating Water	Purple	PVC Jacket	Purple	White
Chilled Water	Blue	PVC Jacket	Blue	White
Dual Temperature Water (Chilled/Hot)	Tan	PVC Jacket	Tan	Black
Condensate (cold form cooling coils)	Grey	PVC Jacket	Grey	White
Make-up Water & Non- Potable	Black	PVC Jacket	Black	White
Refrigerant Suction	White	PVC Jacket	White	Black
Domestic Hot Water	Orange	PVC Jacket	Orange	Black
Domestic Cold Water	Light Blue	PVC Jacket	Light Blue	Black
Storm Drainage	White	PVC Jacket	White	Black
Sanitary, Drain, Waste, Vent	Not Applicable	Not Applicable	Grey	White
Fire Suppression	Red	Painted Piping	Red	White

Natural Gas	Yellow	Painted Piping	Yellow	Black
Caustic Waste (acid waste, condensate drainage from condensing gas fired equipment)	Not Applicable	Not Applicable	Brown	White

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 DUCTWORK IDENTIFICATION

- A. General: Identify air supply, return, and exhaust, intake and relief ductwork with duct markers and arrows, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork color).
- B. Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50 foot spacings along exposed runs.

3.3 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
 1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
 2. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums), accessible ceiling plenums/spaces, and exterior non-concealed locations.
 3. Near each valve and control device.
 4. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 5. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 6. At access doors, manholes and similar access points which permit view of concealed piping.
 7. Near major equipment items and other points of origination and termination.

8. Spaced intermediately at maximum spacing of 50 feet along each piping run, except reduce spacing to 25 feet in congested areas of piping and equipment.
 9. On piping above removable acoustical ceilings, space at 20 feet maximum.
- B. Color Coded PVC Piping Jackets: Install color coded piping jackets on all exposed piping systems, including utility spaces, and finished spaces exposed to view, with the exception of non-insulated drainage systems, fire suppression systems, and natural gas. Fire suppression systems and gas systems shall be continuously painted.
- C. Painting:
1. Prepare surface as per manufacturer's written instructions and recommendations. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated. Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than SSPC-SP 3.
 2. Steel Substrates
 - a. Epoxy System:
 - 1) Prime Coat: Anticorrosive epoxy primer.
 - 2) Intermediate Coat: Matching topcoat.
 - 3) Topcoat: Epoxy semi-gloss.
 3. Paint the following piping systems for all exposed locations.
 - a. Gas piping.
 - b. Fire protection piping, including, fire sprinkler and standpipe. Coordinate final color selection on a room-by-room basis with Architect. Certain performance spaces (and similar) may be painted a color other than red.

3.4 UNDERGROUND PIPING IDENTIFICATION

- A. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6 inches to 8 inches below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16 inch, install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.5 VALVE IDENTIFICATION

- A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system. Provide one copy of the valve schedule

in each O&M manual and one copy installed in the frame under Plexiglas and securely mounted to the mechanical room wall in a location approved by the owner.

3.6 MECHANICAL EQUIPMENT IDENTIFICATION

- A. General: Install engraved plastic laminate marker on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment:
1. Fuel-burning units including heaters, ventilation units, and water heaters.
 2. Pumps, compressors, and similar motor-driven units.
 3. Coils, evaporators, and similar equipment.
 4. Fans, blowers, primary balancing dampers and mixing boxes.
 5. Air handling units and fans.
 6. Tanks and pressure vessels.

3.7 CEILING ACCESS IDENTIFICATION

- A. General: Install ceiling markers on ceiling tile, adjacent exposed grid support member, or access door to indicate which ceiling panel is to be removed to obtain access to the following ceiling concealed items:
1. Equipment
 2. Tagged valves
 3. Control dampers
 4. Fire and/or smoke dampers
 5. Duct smoke detectors
 6. Coils.
 7. Control system panels.
- B. Provide the name, designation, and/or valve tag number for each concealed item engraved on the marker.

3.8 ADJUSTING AND CLEANING

- A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
- B. Cleaning: Clean face of identification devices.

END OF SECTION

SECTION 230510 - HYDRONIC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.
- B. The following Division 23 Sections apply to this Section:
 - 1. "Basic Mechanical Requirements."
 - 2. "Basic Mechanical Materials and Methods."
 - 3. "Valves."
 - 4. "Supports and Anchors."

1.2 SUMMARY

- A. This Section includes piping systems for hot water heating and make-up water for the systems, blow-down drain lines, and condensate drain piping. Piping materials and equipment specified in this Section include:
 - 1. Pipes, fittings, and specialties;
 - 2. Special duty valves;
 - 3. Hydronic specialties.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 2 Section "Earthwork" for trenching and backfilling materials and methods for underground piping installations.
 - 2. Division 230055 Section "Basic Mechanical Materials and Methods" for sealing pipe penetrations through basement walls and fire and smoke barriers.
 - 3. Division 230100 Section "Valves" for gate, globe, ball and check valves.
 - 4. Division 230519 Section "Meters and Gauges" for thermometers, flow meters, and pressure gauges.
 - 5. Division 230190 Section "Mechanical Identification" for labeling and identification of hydronic piping system.
 - 6. Division 235250 Section "Mechanical Insulation" for pipe insulation.
 - 7. Division 230540 Section "HVAC Pumps" for pumps, motors and accessories for hydronic systems.
 - 8. Division 230923 Section "Direct Digital Control System" for temperature control valves and sensors.
 - 9. Division 230593 Section "Testing, Adjusting and Balancing" for procedures for hydronic systems adjusting and balancing.

1.3 DEFINITIONS

- A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

1.4 SUBMITTALS

- A. Product Data, including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions for each hydronic specialty and special duty valve specified.
 - 1. Furnish flow and pressure drop curves for diverting fittings and calibrated plug valves, based on manufacturer's testing.
- B. Maintenance Data for hydronic specialties and special duty valves, for inclusion in operating and maintenance manual specified in Division 1 and Division 23 Section "Basic Mechanical Requirements."
- C. Welders' certificates certifying that welders comply meet the quality requirements specified in Quality Control below.
- D. Certification of compliance with ASTM and ANSI manufacturing requirements for pipe, fittings, and specialties.
- E. Reports specified in Part 3 of this Section.

1.5 QUALITY CONTROLS

- A. Regulatory Requirements: Comply with the provisions of the following:
 - 1. ASME B 31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
 - 2. Fabricate and stamp coalescing air and dirt separators and compression tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
 - 3. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.
 - a. IMC International Mechanical Code 2018.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate the installation of pipe sleeves for foundation wall penetrations.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide hydronic piping system products from one of the following:
1. Grooved Mechanical Joint Pipe, Fittings, and Couplings:
 - a. Gustin-Bacon Co.
 - b. ITT Grinnell Corp.
 - c. Stockham Valves & Fittings, Inc.
 - d. Victaulic Company of America.
 2. Calibrated Plug Valves:
 - a. Bell & Gossett ITT; Fluid Handling Div.
 - b. Taco, Inc.
 - c. Approved Equal
 3. Pump Discharge Valves:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett ITT; Fluid Handling Div.
 - d. Taco, Inc.
 4. Safety Relief Valves:
 - a. Amtrol, Inc.
 - b. Bell & Gossett ITT; Fluid Handling Div.
 - c. Spirax Sarco.
 - d. Watts Regulator Co.
 5. Air Vents (manual and automatic):
 - a. Armstrong Machine Works.
 - b. Bell & Gossett ITT; Fluid Handling Div.
 - c. Hoffman Specialty ITT; Fluid Handling Div.
 - d. Spirax Sarco.
 6. Coalescing Air and Dirt Separators:
 - a. Amtrol, Inc.
 - b. Taco Pumps, Inc.
 - c. Bell & Gossett ITT; Fluid Handling Div.
 7. Expansion Tanks:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett ITT; Fluid Handling Div.
 - d. Taco, Inc.

8. Chemical Feeder:
 - a. Culligan USA.
 - b. Vulcan Laboratories, Subsidiary of Clow Corp.
 - c. York-Shipley, Inc.

9. Diverting Fittings:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett ITT; Fluid Handling Div.
 - d. Taco, Inc.
10. Dielectric Waterway Fittings: Victaulic Company of America
11. Dielectric Unions:
 - a. Perfection Corp.
 - b. Watts Regulator Co.

12. Y-Pattern Strainers:
 - a. Armstrong Machine Works.
 - b. Hoffman Specialty ITT; Fluid Handling Div.
 - c. Metraflex Co.
 - d. Spirax Sarco.
 - e. Trane Co.
 - f. Victaulic Co. of America.
 - g. Watts Regulator Co.

13. Flexible Connectors Braided Stainless Steel Type.
 - a. Flexonics Division VOP Inc.
 - b. Keflex, Inc.
 - c. Mason Industries Inc.
 - d. Metraflex Co.

14. Flexible Connectors Spherical Type
 - a. Keflex, Inc.
 - b. Mason Industries Inc.
 - c. Metraflex Co.

2.2 PIPE AND TUBING MATERIALS

- A. General: Refer to Part 3 Article "PIPE APPLICATIONS" for identification of where the below materials are used.

- B. Drawn Temper Copper Tubing: ASTM B 88, Type L.

- C. Annealed Temper Copper Tubing: ASTM B 88, Type K.

- D. Steel Pipe: ASTM A 53, Schedule 40, Type S (seamless) or Type E (electric-resistance welded), black steel pipe, plain ends and rolled groove ends.

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel, Type S (seamless) or Type E (electric-resistance welded)
- E. CPVC Plastic Pipe: ASTM D 1785, Schedule 80, plain ends.

2.3 FITTINGS

- A. Cast-Iron Threaded Fittings: ANSI B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.
- B. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.
- C. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.
- D. Wrought-Copper Fittings: ANSI B16.22, streamlined pattern.
- E. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.
- F. Cast-Iron Threaded Flanges: ANSI B16.1, Class 125; raised ground face, bolt holes spot faced.
- G. Cast Bronze Flanges: ANSI B16.24, Class 150; raised ground face, bolt holes spot faced.
- H. Steel Flanges and Flanges Fittings: ANSI B16.5, including bolts, nuts, and gaskets of the following material group, end connection and facing:
 1. Material Group: 1.1.
 2. End Connections: Butt Welding.
 3. Facings: Raised face.
- I. Grooved Mechanical Fittings: ASTM A 536, Grade 65-45-12. Ductile Iron; ASTM A 47 Grade 32510 Malleable Iron; ASTM A 53, Type F, or Types E or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.
- J. Grooved Mechanical Couplings: Consist of ductile or malleable iron housing, a synthetic rubber gasket of a central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
- K. Unions: ANSI B16.39 malleable-iron, Class 150, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends. Threads shall conform to ANSI B1.20.1.

- L. Dielectric Unions: Threaded or soldered end connections for the pipe materials in which installed; constructed to isolate dissimilar metals, prevent galvanic action, and prevent corrosion.
- M. Flexible Connectors Braided Type: Stainless steel bellows with woven flexible bronze wire reinforcing protective jacket; minimum 150 psig working pressure, maximum 250 degrees F operating temperature. Connectors shall have flanges or threaded end connections to match equipment connected; and shall be capable of 3/4-inch misalignment.
- N. Flexible Connectors Spherical Type: Neoprene or butyl; reinforced; minimum 150 psig working pressure, maximum 250 degrees F operating temperature. Connectors shall have flanges connections to match equipment connected.

2.4 JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, 50-50, Tin-Lead, for hot water and drain piping.
- B. Solder Filler Metals: ASTM B 32, 95-5, Tin-Antimony, for heating hot water.
- C. Brazing Filler Metals: AWS A5.8, Classification Bag 1 (Silver).
 - 1. **WARNING:** Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
- D. Welding Materials: Comply, with Section II, Part C. ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
- E. Gasket Material: Thickness, material, and type suitable for fluid to be handled, and design temperatures and pressures.
- F. CPVC Solvent Cement: ASTM D 2564.

2.5 GENERAL DUTY VALVES

- A. General duty valves (i.e., globe, check, and ball valves) are specified in Division 230100 Section "Valves." Special duty valves are specified below by their generic name; refer to Part 3 Article "VALVE APPLICATION" for specific uses and applications for each valve specified.

2.6 SPECIAL DUTY VALVES

- A. Calibrated Plug Valves: 125 psig water working pressure, 250 degrees F maximum operating temperature, bronze body, plug valve with calibrated orifice. Provide with connections for portable differential pressure meter with integral check valves and seals.

Valve shall have integral pointer and calibrated scale to register degree of valve opening. Valves 2 inch and smaller shall have threaded connections and 2-1/2-inch valves shall have flanges connections.

- B. Safety Relief Valves: 125 psig working pressure and 250 degrees F maximum operating temperature; designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made of brass and rubber. Select valve to suit actual system pressure and Btu capacity.
- C. Combined Pressure/Temperature Relief Valves: Diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment. Safety relief valve designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made of brass and rubber; 125 psig working pressure and 250 deg F maximum operating temperature. Select valve to suit actual system pressure and Btu capacity. Provide with fast fill feature for filling hydronic system.
- D. Pressure Reducing Valves: Diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment.
- E. Balancing Valves
 - 1. Manual Balancing Valve:
 - a. Provide precisely calibrated balance valves to preset, balance and meter flow. Balance valve to be cast iron or bronze body with bronze disc.
 - b. Valve to have differential pressure meter fittings with built-in check valves.
 - c. Valve shall have integral pointer to register degree of valve opening.
 - d. Valve shall be constructed for 125 psi working pressure at a maximum of 250 degrees Fahrenheit, and be supplied with preformed insulation cover.
 - e. Valve shall have internal seals to prevent leakage around rotating element.
 - f. Manufacturer: Subject to compliance with requirements, provide balancing valves for Bell and Gossett "circuit Setter" model or approve equal.

2.7 HYDRONIC SPECIALTIES

- A. Manual Air Vent: Bronze body and nonferrous internal parts; 150 psig working pressure, 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; and having 1/8-inch discharge connection and 1/2-inch inlet connection.

- B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150 psig working pressure, 240 degrees F operating temperature; and having 1/4-inch discharge connection and 1/2-inch inlet connection.
- C. Chemical Feeder: Bypass type chemical feeders of 5-gallon capacity, welded steel construction; 125 psig working pressure; complete with fill funnel and inlet, outlet, and drain valves.
 - 1. Chemicals shall be specially formulated to prevent accumulation of scale and corrosion in piping system and connected equipment, developed based on a water analysis of make-up water.
 - 2. Diverting Fittings: Wrought copper with solder ends; 125 psig working pressure, 250 degrees F maximum operating temperature. Indicate flow direction on fitting.
 - 3. Y-Pattern Strainers: 125 psig working pressure cast-iron body (ASTM A 126, Class B), flange ends for 2-1/2 inch and larger, threaded connections for 2 inch and smaller, bolted cover, perforated Type 304 stainless steel basket, and bottom drain connection.
 - 4. Basket Strainers: 125 psig working pressure; high tensile cast-iron body (ASTM A 126, Class B), flanges end connections, bolted cover, perforated Type 304 stainless steel basket, and bottom drain connection.
- D. Air separator: Welded black steel; ASME constructed and labeled for minimum 125 psig water working pressure and 375 F operating temperature; perforated stainless steel air collector tube designed to direct released air into compression tank; tangential inlet and outlet connections; screwed connections up to and including 2-inch NPS; flanges connections for 1-1/2-inch NPS and above; threaded blowdown connection; sized as indicated for full system flow capacity.
- E. Expansion Tank: Floor mounted, bladder/diaphragm expansion tank constructed of steel per ASME Section VIII, Div 1, for a working pressure of 125 psig.

PART 3 EXECUTION

3.1 PIPE APPLICATIONS

- A. All Applications Except Condenser Water and Acidic Waste:
 - 1. Install Type L, drawn copper tubing with wrought copper fittings and solder joints for 2 inch and smaller, above ground, within building. Install Type K, annealed temper copper tubing for 2 inch and smaller without joints, below ground or within slabs.
 - 2. Install steel pipe with threaded joints and fittings for 2 inch and smaller.
- B. Condenser Water and Acidic Waste (such as condensate drainage from condensing gas fired equipment): Schedule 80 CPVC pipe with solvent-welded joints.

3.2 PIPING INSTALLATIONS

- A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and all branch connections.
- C. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- E. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- F. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- G. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap.
- H. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Division 7 for special sealers and materials.
- I. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.
- J. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.
- K. Install branch connections to mains using Tee fittings in main with take-off out the bottom of the main, except for up-feed risers which shall have take-off out the top of the main line.
- L. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated. Unions are not required on flanges devices.
- M. Install dielectric unions to join dissimilar metals.
- N. Install flanges on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

- O. Install flexible connectors at inlet and discharge connections to pumps (except inline pumps) and other vibration producing equipment.
- P. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, inline pump, and elsewhere as indicated. Install nipple and ball valve in blow down connection of strainers 2 inch and larger.
- Q. Anchor piping to ensure proper direction of expansion and contraction. Expansion loops and joints are indicated on the Drawings and specified in Division 230529 Section "Supports and Anchors."

3.3 HANGERS AND SUPPORTS

- A. General: Hanger, supports, and anchors devices are specified in Division 230529 Section "SUPPORTS AND ANCHORS." Conform to the table below for maximum spacing of supports:
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs.
 - 2. Adjustable roller hangers for individual horizontal runs where shown on the drawings.
 - 3. For multiple horizontal runs, supported on a trapeze hanger.

- C. Steel Piping: Install hangers with the following minimum rod sizes and maximum spacing:

Nom. Pipe Size-Inch Max. Span-Ft. Min. Rod Size-Inch

Up to 1	7	3/8
1-1/2	9	3/8
2	10	3/8
2-1/2	11	3/8
3	12	3/8
4	14	1/2
5	16	5/8
6	17	5/8
8	19	5/8
10	20	3/4
14	23	7/8
14	25	1

- D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4": Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1": Maximum span, 6 feet; minimum rod size, 1/4 inch.

3. NPS 1-1/2": Maximum span, 8 feet; minimum rod size, 3/8 inch.
 4. NPS 2": Maximum span, 8 feet; minimum rod size, 3/8 inch.
 5. NPS 2-1/2": Maximum span, 9 feet; minimum rod size, 3/8 inch.
 6. NPS 3": Maximum span, 10 feet; minimum rod size, 3/8 inch.
- E. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.4 PIPE JOINT CONSTRUCTION

- A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
- B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
 2. Purge the pipe and fittings during brazing, with an inert gas (i.e., nitrogen or carbon dioxide) to prevent formation of scale.
 3. Heat joints using oxy-acetylene torch. Heat to proper and uniform temperature.
- C. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe fittings and valves as follows:
1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 2. Align threads at point of assembly.
 3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
 4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
- D. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used. Welded Joints: Comply with the requirement in ASME Code B31.9-"Building Services Piping."
- E. Flange Joints : Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
- F. Grooved Joints: Assemble joints in accordance with fitting manufacturers written instructions.

- G. CPVC Joints: Prepare surfaces to be solvent cemented by wiping with a clean cloth moistened with acetone or methylethyl keytone. Solvent cement joints in accordance with ASTM D2846.

3.5 VALVE APPLICATIONS

- A. General Duty Valve Applications: Where specific valve types are not indicated, the following requirements apply:
 - 1. Shut-off duty: Use ball valves. See valve specification for additional information.
 - 2. Throttling duty: Use globe and ball valves. See valve specification for additional information.
 - 3. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.
 - 4. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, elsewhere as indicated.
- B. Install calibrated plug valves on the outlet of each heating or cooling element and elsewhere as required to facilitate system balancing.
- C. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.
- D. Install nonslam check valves on each pump discharge and elsewhere as required to control flow direction.
- E. Install safety relief valves on hot water generators, and elsewhere as required by ASME Boiler and Pressure Vessel Code.
- F. Pipe discharge to floor without valves. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 1 for installation requirements.
- G. Install pressure reducing valves on hot water generators, and elsewhere as required to regulate system pressure.

3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in the system, at reheat coils and elsewhere as required for system air venting.
- B. Install automatic air vents at the top of main risers and at heat transfer coils in air handling units.
- C. Install air separator in pump suction lines. Run piping to compression tank with 1/4 inch per foot (2 percent) upward slope towards tank. Install blowdown piping with gate valve; extend to nearest drain.

- D. Install pump suction diffusers on pump suction inlet, adjust foot support to carry weight of suction piping. Support from inertia base when one is used. Install nipple and ball valve in blowdown connection.
- E. Install pump discharge valves in horizontal or vertical position with stem in upward position. Allow clearance above stem for check mechanism removal.
- F. Install shot-type chemical feeders in each hydronic system where indicated; in upright position with top of funnel not more than 48 inch above floor. Install feeder in bypass line, off main using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
- G. Install compression tanks from the floor or structure above sufficient for the weight of the tank, piping connections, and fittings, plus weight of water assuming a full tank of water. Do not overload building components and structural members.

3.7 FIELD QUALITY CONTROL

- A. Preparation for testing: Prepare hydronic piping in accordance with ASME B 31.9 and as follows:
 - 1. Leave joints including welds uninsulated and exposed for examination during the test.
 - 2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
 - 3. Flush system with clean water. Clean strainers.
 - 4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanges joints at which blinds are inserted to isolate equipment need not be tested.
 - 5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.
- B. Testing: Test hydronic piping as follows:
 - 1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
 - 2. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of the liquid.
 - 3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
 - 4. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure. The test pressure shall not

exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, Building Services Piping.

5. After the hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

3.8 ADJUSTING AND CLEANING

- A. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.
- B. Mark calibrated name plates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- C. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

3.9 COMMISSIONING

- A. Fill system and perform initial chemical treatment.
- B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
- C. Before operating the system perform these steps:
 1. Open valves to fully open position. Close coil bypass valves.
 2. Remove and clean strainers.
 3. Check pump for proper direction; correct improper wiring.
 4. Set automatic fill valves for required system pressure.
 5. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
 6. Set temperature controls so all coils are calling for full flow.
 7. Check operation of automatic bypass valves.
 8. Check and set operating temperatures of boiler to design requirements.
 9. Lubricate motors and bearings.

END OF SECTION

SECTION 230519 METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Filled-system thermometers.
 2. Liquid-in-glass thermometers.
 3. Light-activated thermometers.
 4. Thermowells.
 5. Dial-type pressure gauges.
 6. Gauge attachments.
 7. Test plugs.
 8. Test-plug kits.
 9. Sight flow indicators.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gauge.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gauges to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 FILLED-SYSTEM THERMOMETERS

- A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
1. Standard: ASME B40.200.
 2. Case: Sealed type, cast aluminum or drawn steel, 4-1/2-inch nominal diameter.
 3. Element: Bourdon tube or other type of pressure element.

4. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
5. Dial: Non-reflective aluminum with permanently etched scale markings graduated in deg F.
6. Pointer: Dark-colored metal.
7. Window: Glass or plastic.
8. Ring: Metal.
9. Connector Type(s): Union joint, adjustable; with ASME B1.1 screw threads.
10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
11. Accuracy: Plus or minus 1 percent of scale range.

B. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Standard: ASME B40.200.
2. Case: Sealed type, cast aluminum or drawn steel ; 6-inch nominal diameter with back flange and holes for panel mounting.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Non-reflective aluminum with permanently etched scale markings graduated in deg F
6. Pointer: Dark-colored metal.
7. Window: plastic .
8. Ring: Metal .
9. Connector Type(s): Union joint, back; with ASME B1.1 screw threads.
10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
11. Accuracy: Plus, or minus 1 percent of scale range.
12. Connector Type(s): Union joint, threaded, back; with ASME B1.1 screw threads.
13. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
14. Accuracy: Plus, or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Cast aluminum ; 6-inch nominal size.
3. Case Form: Back angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue organic liquid.
5. Tube Background: Non-reflective aluminum with permanently etched scale markings graduated in deg F.
6. Window: Glass or plastic.
7. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
8. Connector: 3/4 inch, with ASME B1.1 screw threads.
9. Accuracy: Plus, or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Plastic; 6-inch nominal size.
3. Case Form: Back angle straight unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Non-reflective with permanently etched scale markings graduated in deg F.
6. Window: Glass or plastic.
7. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
8. Connector: 3/4 inch, with ASME B1.1 screw threads.
9. Accuracy: Plus, or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

C. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Cast aluminum 7-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
6. Window: Glass or plastic
7. Stem: Aluminum and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.

9. Accuracy: Plus, or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

D. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Plastic 7-inch or 9-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Non-reflective aluminum with permanently etched scale markings graduated in deg F.
6. Window: Glass
7. Stem: Aluminum and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
9. Accuracy: Plus, or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 LIGHT-ACTIVATED THERMOMETERS

A. Direct-Mounted, Light-Activated Thermometers:

1. Case: Metal ; 7-inch nominal size unless otherwise indicated.
2. Scales: Deg F.
3. Case Form: Adjustable angle.
4. Connector: 1-1/4 inches with ASME B1.1 screw threads.
5. Stem: Aluminum and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
6. Display: Digital.
7. Accuracy: Plus, or minus 2 deg F.

B. Remote-Mounted, Light-Activated Thermometers:

1. Case: Plastic, for wall mounting.
2. Scales: Deg F
3. Sensor: Bulb and thermister wire.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
4. Display: Digital.
5. Accuracy: Plus, or minus 2 deg F.

2.4 DUCT-THERMOMETER MOUNTING BRACKETS

- A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.5 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: CNR.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

- B. Heat-Transfer Medium: Mixture of graphite and glycerin .

2.6 DIAL-TYPE PRESSURE GAUGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gauges:

1. Standard: ASME B40.100.
2. Case: Liquid-filled Open-front, pressure relief nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi].
7. Pointer: Dark-colored metal.
8. Window: Glass or plastic .
9. Ring: Metal
10. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

B. Remote-Mounted, Metal-Case, Dial-Type Pressure Gauges:

1. Standard: ASME B40.100.

2. Case: Liquid-filled type; cast aluminum or drawn steel ; 4-1/2-inch nominal diameter with back front flange and holes for panel mounting.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Accuracy: plus or minus 2 percent of middle half of scale range.

C. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gauges:

1. Standard: ASME B40.100.
2. Case: Sealed type; plastic; 4-1/2-inch nominal diameter with back flange and holes for panel mounting.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Accuracy: plus or minus 2 percent of middle half of scale range.

2.7 GAUGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of brass pipe with NPS 1/2 pipe threads.
- C. Valves: Brass ball, with NPS 1/4, ASME B1.20.1 pipe threads.

2.8 TEST PLUGS

- A. Description: Test-station fitting made for insertion in piping tee fitting.
- B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- C. Thread Size: NPS 1/4, ASME B1.20.1 pipe thread.

- D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F
- E. Core Inserts: Chlorosulfonated polyethylene synthetic and self-sealing rubber.

2.9 SIGHT FLOW INDICATORS

- A. Description: Piping inline-installation device for visual verification of flow.
- B. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
- C. Minimum Pressure Rating: 150 psig.
- D. Minimum Temperature Rating: 200 deg F.
- E. End Connections for NPS 2 and Smaller: Threaded.
- F. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- H. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.
- I. Install remote-mounted pressure gauges on panel.

- J. Install valve and snubber in piping for each pressure gauge for fluids (except steam).
- K. Install valve and syphon fitting in piping for each pressure gauge for steam.
- L. Install test plugs in piping tees.
- M. Install flow indicators in piping systems in accessible positions for easy viewing.
- N. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- O. Install flowmeter elements in accessible positions in piping systems.
- P. Install wafer-orifice flowmeter elements between pipe flanges.
- Q. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- R. Install permanent indicators on walls or brackets in accessible and readable positions.
- S. Install connection fittings in accessible locations for attachment to portable indicators.
- T. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
- U. Install thermometers in the following locations:
 - 1. Inlet and outlet of each hydronic boiler.
 - 2. Inlet and outlet of each hydronic manifolds.
- V. Install pressure gauges in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Suction and discharge of each pump.

3.2 CONNECTIONS

- A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flow meter transmitters to meters.
- D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gauges to proper angle for best visibility.

3.4 PRESSURE-GAUGE SCHEDULE

- A. Pressure gauges at discharge of each pressure-reducing valve shall be one of the following:
 - 1. Liquid-filled direct-mounted, metal case.
 - 2. Sealed-mounted, plastic case.
 - 3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.
- B. Pressure gauges at suction and discharge of each pump shall be one of the following:
 - 1. Liquid-filled direct-mounted, metal case.
 - 2. Sealed, direct-mounted, plastic case.
 - 3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

END OF SECTION

SECTION 230529 - SUPPORTS AND ANCHORS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 23 Sections apply to this section:
 - 1. "Basic Mechanical Requirements."
 - 2. "Basic Mechanical Materials and Methods."
 - 3. "Basic Piping Materials and Methods."

1.2 SUMMARY

- A. This section includes the following:
 - 1. Horizontal-piping hangers and supports.
 - 2. Vertical-piping clamps.
 - 3. Hanger-rod attachments.
 - 4. Building attachments.
 - 5. Saddles and shields.
 - 6. Spring hangers and supports.
 - 7. Miscellaneous materials.
 - 8. Pipe alignment guides.
 - 9. Anchors.
 - 10. Equipment supports.
 - 11. Ductwork support and Anchors.
- B. Related sections: The following sections contain requirements that relate to this section:
 - 1. Division 230050 Section "Basic Mechanical Materials and Methods" for materials for anchoring piping systems to building structure.
 - 2. Division 230050 Section "Basic Mechanical Materials and Methods" for field-applied painting requirements.
 - 3. Division 230548 Section "Vibration Control" for vibration-isolation hangers and supports.
 - 4. Division 235250 Section "Mechanical Insulation" for pipe insulation.

1.3 DEFINITIONS

- A. Terminology used in this section is defined in MSS SP-90.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with conditions of contract and Division 1 specification sections.
- B. Product data, including installation instructions for each type of support and anchor.
- C. Product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.
- D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.
- E. Assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.
- F. Submit two copies of the latest edition of the following MSS Standards for project reference. One copy shall be returned and maintained at the job site trailer.
 - 1. MSS SP-58: Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation
 - 2. MSS SP-69: Pipe Hangers and Supports - Selection and Application (ANSI-approved American National Standard)
 - 3. MSS SP-89: Pipe Hangers and Supports -Fabrication and Installation Practices
- G. Maintenance data for supports and anchors for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 230010 Section "Basic Mechanical Requirements."

1.5 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Qualify welding processes and welding operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
- C. Regulatory Requirements: Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.
- D. NFPA Compliance: Hangers and supports shall comply with NFPA standard No. 13 when used as a component of a fire protection system.

- E. UL and FM Compliance: Hangers, supports, and components shall be listed and labeled by UL and FM where used for fire protection piping systems.

PART 2 PRODUCTS

2.1 MISCELLANEOUS MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1. part cement to 3. part sand, by volume, with minimum amount of water required for placement and hydration.
- C. Pipe Alignment Guides: Factory fabricated, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

2.2 MANUFACTURED UNITS

- A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.
- B. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.
- C. Pipe attachments shall have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
- D. All hangers on insulated piping shall be oversized to be outside of the pipe insulation.
- E. Thermal Hanger Shield Inserts: 100-psi average compressive strength, waterproofed calcium silicate, encased with a sheet metal shield. Insert shall cover entire circumference of the pipe; shield shall cover the bottom 1/2 circumference of the pipe. Insert and shield and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
- F. Pipe Hangers: MSS Type 5, for suspension of piping when off-center closure allowing installation of hanger before erection of piping is desired; 1/2" to 4".
- G. Adjustable Swivel Pipe Rings: MSS Type 6, for suspension of non-insulated stationary pipe lines; 3/4" to 8".

2.3 HORIZONTAL-PIPING HANGERS AND SUPPORTS:

- A. General: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper-piping systems.
- B. Adjustable Steel Clevis Hangers: MSS Type 1, for suspension of non-insulated or insulated stationary pipe lines; 1/2" to 30".
- C. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
 - D. Plate: Hold Down Clamp type, for support of piping where horizontal movement resulting from expansion and contraction take place, and where low coefficient of friction is desired. Select proper plate type.
- E. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe-based support and cast-iron floor flange, for stanchion type support where vertical adjustment is required; 2-1/2" to 36".
- F. Single Pipe Rolls: MSS Type 41, for suspension of pipe from two rods where longitudinal movement due to expansion and contraction may occur; 1" to 30".
- G. Adjustable Roller Hangers: MSS Type 43, for suspension of pipe from a single rod where horizontal movement may occur because of expansion or contraction, 2-1/2" to 20".
- H. Pipe Roll Stands: MSS Type 44, for support of pipe where longitudinal movement resulting from expansion and contraction may take place, but vertical adjustment is unnecessary; 2" to 24".
- I. Pipe Rolls and Plates: MSS Type 45, for support of pipe where small horizontal movement due to expansion and contraction may occur and where vertical adjustment is unnecessary; 2" to 24".
- J. Adjustable Pipe Roll Stands: MSS Type 46, to support pipe lines where vertical and lateral adjustment during installation may be required in addition to provision for expansion and contraction; 2" to 30".

2.4 VERTICAL-PIPING CLAMPS

- A. General: Except as otherwise indicated, provide factory-fabricated vertical-piping clamps complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and

manufacturer's published product information. Select size of vertical piping clamps for copper-piping systems.

- B. Two-Bolt Riser Clamps: MSS Type 8

2.5 HANGER-ROD ATTACHMENTS:

- A. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS sp-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.

1. Concrete Inserts: MSS Type 18.
2. Top Beam C-Clamps: MSS Type 19.
3. Side Beams or Channel Clamps: MSS Type 20.
4. Center Beam Clamps: MSS Type 21.
5. Welded Beam Attachments: MSS Type 22.
6. C-Clamps: MSS Type 23.
7. Top Beam Clamps: MSS Type 25.
8. Side Beam Clamps: MSS Type 27.
9. Steel Beam Clamps W/Eye Nut: MSS Type 28.
10. Linked Steel Clamps W/Eye Nut: MSS Type 29.
11. Malleable Beam Clamps: MSS Type 30.
12. Steel Brackets: One of the following for indicated loading:
 - a. Light Duty: MSS Type 31, up to 750 pounds.
 - b. Medium Duty: MSS Type 32, up to 1500 pounds.
 - c. Heavy Duty: MSS Type 33, up to 3000 pounds.
13. Side Beam Brackets: MSS Type 34.
14. Plate Lugs: MSS Type 57.
15. Horizontal Travelers: MSS Type 58.

2.6 SADDLES AND SHIELDS

- A. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
- B. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.

- C. Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.
- D. Thermal Hanger Shields: constructed of 360 degrees insert of high density, 100 psi, water-proofed calcium silicate, encased in 360-degree sheet metal shield. Provide assembly of same thickness as adjoining insulation.

2.7 SPRING HANGERS AND SUPPORTS:

- A. General: Except as otherwise indicated, provide factory-fabricated spring hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select spring hangers and supports to suit pipe size and loading.
 - 1. Restraint Control Devices: MSS Type 47.
 - 2. Spring Cushion Hangers: MSS Type 48.
 - 3. Spring Cushion Roll Hangers: MSS Type 49, for equipping type 41 roll hanger with springs.

2.8 MANUFACTURERS OF HANGERS AND SUPPORTS

- A. Available Manufacturers: Subjects to compliance with requirements, manufacturers offering hangers and support which may be incorporated in the work include, but are not limited to, the following:
 - 1. B-Line systems Inc.
 - 2. Carpenter and Patterson, Inc.
 - 3. Corner & Lada Co., Inc.
 - 4. Elcen Metal Products Co.
 - 5. Fee & Mason Mfg. Co.; Div. Figgie International.
 - 6. ITT Grinnel Corp.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions under which supports and anchors are to be installed. Do not proceed with installing until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69 and SP-89. Arrange for grouping of

parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.

- B. Install building attachments within concrete or to structural members. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts. In existing concrete frame structures, attach supports to sides only of beams or joists when using power activated fasteners or concrete anchors.
- C. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- D. Field-Fabricated, Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS D-1.1.
- E. Support fire protection systems piping independently from other piping systems.
- F. Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
- G. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.
- I. Insulated Piping: Comply with the following installation requirements, or install thermal hanger shield inserts per Part 2.
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
 - 2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
 - 3. Shields: Install protective shields MSS Type 40 on insulated piping. Shields shall span an arc of 180 degrees and shall have dimensions in inch not less than the following:

<u>NPS</u>	<u>LENGTH</u>	<u>THICKNESS</u>
1/4 THROUGH 3-1/2	12	0.048
	12	0.060
5	18	0.060

4. Pipes 1-1/2 inch and larger shall have 360-degree arc of 100 psi average compressive strength calcium silicate inserts.
5. Insert material shall be at least as long as the protective shield.
6. Thermal Hanger Shields: Install where indicated, with insulation of same thickness as piping.

3.3 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to control movement to compensators.
- D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required accommodating both expansion and contraction of piping.

3.4 INSTALLATION OF PIPE ALIGNMENT GUIDES

- A. Install pipe alignment guides on piping that adjoins expansion joints and elsewhere as indicated.
- B. Anchor to building substrate.

3.5 EQUIPMENT SUPPORTS

- A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
- B. Grouting: Place grout under supports for piping and equipment.

3.6 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:
- D. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 1. Obtain fusion without undercut or overlap.
 - 2. Remove welding flux immediately.
 - 3. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.7 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum dry film thickness of 2. mils.
- C. For galvanized surfaces clean welds bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 230540 - HVAC PUMPS

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes the following types of HVAC pumps:
 - 1. In-line circulators.
 - 2. In-line pumps.
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Division 23 Section "Electrical Requirements for Mechanical Equipment" for electric motors, variable speed drives, connections, and accessories.
 - 2. Division 23 Section "Meters and Gauges" for temperature and pressure gauges and connectors.
 - 3. Division 23 Section "Vibration Control" for inertia pads, isolation pads, spring supports, and spring hangers.
 - 4. Division 23 Section "Automatic Temperature Controls" for interlock wiring between pumps, and between pumps and field-installed control devices.

1.2 SUBMITTALS:

- A. General: Submit the following in accordance with conditions of Contract and Division 1 Specification Sections.
- B. Product data including certified performance curves of selected models indicating selected pump's operating point, dimensions, weights (shipping, installed, and operating), furnished specialties, and accessories.
- C. Shop drawings showing layout and connections for HVAC pumps. Include setting drawings with templates, and directions for installation of foundation bolts and other anchorages.
- D. Wiring diagrams detailing wiring for power, signal, and control systems, differentiating between manufacturer-installed wiring and field-installed wiring.
- E. Maintenance data for HVAC pumps for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 23 Section "Basic Mechanical Requirements."
- F. Reports: Submit a written report for each quality control test indicating all data. When applicable include the signature of the commissioning agent or inspection authority.

1.3 QUALITY CONTROL

- A. Hydraulic Institute Compliance: Design, manufacture, and install HVAC pumps in accordance with "Hydraulic Institute Standards."
- B. National Electrical Code Compliance: Provide components complying with NFPA 70 "National Electrical Code."
- C. UL Compliance: Provide HVAC pumps which are listed and labeled by UL, and comply with UL Standard 778 "Motor Operated Water Pumps."
- D. NEMA Compliance: Provide electric motors and components that are listed and labeled NEMA.
- E. Single Source Responsibility: Obtain HVAC pumps from a single manufacturer.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Store pumps in a dry location.
- B. Retain shipping flange protective covers and protective coatings during storage.
- C. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the following:
 - 1. In-line Pumps:
 - a. Bell & Gossett, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Taco Pumps

2.2 PUMPS, GENERAL

- A. Pumps and Circulators: Factory-assembled and factory-tested. Fabricate casings to allow removal and replacement of impellers without necessity of disconnecting piping. Type, sizes, and capacities shall be as indicated. Provide pressure gauge tapings on the suction and discharge.
- B. Design Criteria: Select pump and impeller to meet specified conditions. The pump capacity head curve shall intersect the specified capacity and head conditions within the maximum efficiency of the impeller furnished. The pump head shall increase

continuously from maximum pump capacity to shut-off with the slope of the capacity head curve approaching horizontal at shut-off. Pump operating speed shall not exceed 3600 RPM unless otherwise indicated.

- C. Preparation for Shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles.
- D. Motors: Conform to NEMA Standard MG-1, general purpose, continuous duty, Design B, except Design C where required for high starting torque; single, multiple, or variable speed with type of enclosure and electrical characteristics as indicated; have built-in thermal-overload protection, and grease-lubricated ball bearings. Select motors that are non-overloading within the full range of the pump performance curve.
- E. Efficiency: Motors shall be “Premium” efficiency grade and have a minimum efficiency in accordance with IEEE Standard 112, Test Method B as specified in Section “Electrical Requirements for Mechanical Equipment”.
- F. Motor Frame: NEMA Standard 48 or 54; use pump manufacturer's standard.
- G. Apply factory finish paint to assembled, tested units prior to shipping.

2.3 IN-LINE PUMPS

- A. General Description: Pumps shall be centrifugal, close-coupled, single-stage, bronze-fitted, radially split case design, with mechanical seals, and rated for 175 psig working pressure and 225 deg F continuous water temperature.
- B. Casings Construction: Cast iron, with threaded companion flanges for piping connections smaller than 2-1/2 inch, and threaded gauge tapings at inlet and outlet connections.
- C. Impeller Construction: Statically and dynamically balanced, closed, overhung, single-suction, cast bronze, conforming to ASTM B 584 and keyed to shaft.
- D. Wear Rings: Removable, bronze.
- E. Pump Shaft and Sleeve: Ground and polished steel shaft, with bronze sleeve and integral thrust bearing. Provide flinger on motor shaft between motor and seals to prevent liquid that leaks past pump seals from entering the motor bearings.
- F. Seals: Mechanical Seals consisting of carbon steel rotating ring, stainless steel spring, ceramic seat, and flexible bellows and gasket.
- G. Motor: Direct-mounted to pump casing; with lifting and supporting lugs in top of motor enclosure.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment foundations, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of HVAC pumps.
- B. Examine rough-in for piping systems to verify actual locations of piping connections prior to installation.

3.2 INSTALLATION

- A. General: Comply with the manufacturer's written installation and alignment instructions.
- B. Install pumps in locations and arranged to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.

3.3 CONNECTIONS

- A. General: Install valves and piping specialties that are same size as the piping connecting the pump.
- B. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles.
- C. Install a nonslam check valve, balancing valve and shut-off valve on the discharge side of in-line pumps and base-mounted end-suction pumps. Do not use triple duty valves.
- D. Install a strainer and shut-off valve or suction diffuser and shut-off valve on the suction side of in-line pumps and base-mounted end-suction pumps.
- E. Install pressure gauges the suction side of the inlet strainer, and the suction and discharge of each pump at the integral pressure gauge tapings provided.
- F. Install braided stainless steel flexible hose connectors on the suction and discharge of all base mounted end suction pumps. Provide vibration isolation pipe supports on all piping connections to pumps (see Specification Section “Vibration Control” for additional information.
- G. Electrical wiring and connections are specified in Division 26 sections
- H. Control wiring and connections are specified in other Division 23 sections.

- I. Field Quality Control
- J. Check suction lines connections for tightness to avoid drawing air into the pump.

3.4 QUALITY CONTROL

- A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:
 - 1. Lubricate oil-lubricated bearings.
 - 2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with the manufacturer's recommendations.
 - 3. Disconnect coupling and check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
 - 4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.
- B. If the pump is to be started against a closed check valve with the discharge shut-off valve open, the steps are the same, except that the discharge shut-off valve is opened some time before the motor is started.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

END OF SECTION

SECTION 230548 - VIBRATION CONTROL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 23 Sections apply to this section:
 - 1. "Basic Mechanical Requirements."
 - 2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY

- A. Extent of vibration control work required by this section is indicated on drawings and schedules, and/or specified in other Division 23 sections.
- B. Types of vibration control products specified in this section include the following:
 - 1. Vibration Isolation Springs.
 - 2. Spring Isolators, Free-Standing.
 - 3. Spring Isolators, Vertically-Restrained.
 - 4. Inertia Base.
 - 5. Fabricated Equipment Bases.
 - 6. Isolation Hangers - Spring
 - 7. Isolation Hangers - Rubber In Shear
 - 8. Flexible Pipe Connectors.
 - 9. Flexible Duct Connections.
 - 10. Neoprene Pads
- C. Related Sections: Refer to other Division 23 Sections for requirements that relate to this section such as the following:
 - 1. Vibration control products furnished as integral part of factory-fabricated equipment assembly.
 - 2. Equipment foundations, hangers, sealants, gaskets, and other work related to vibration control work.
 - 3. Requirements of electrical connections to equipment isolated on vibration control products.
 - 4. Requirements of duct connections to air handling equipment isolated on vibration control products.

1.3 SUBMITTALS

- A. **Product Data:** Submit manufacturer's technical product data and installation instructions for each type of vibration control product. Submit schedule showing size, type, deflection, and location for each product furnished.
- B. **Shop Drawings:** Submit manufacturer's assembly-type shop drawings indicating dimensions, weights, required clearances, and method of assembly of components. Detail bases, and show location of equipment anchoring points, coordinated with equipment manufacturer's shop drawings.
- C. **Maintenance Data:** Submit maintenance data for each type of vibration control product. Include this data, product data, and shop drawings in maintenance manual and clearances; in accordance with requirements of Division 1.

1.4 QUALITY ASSURANCE

- A. Except as otherwise indicated, obtain vibration control products from single manufacturer.
- B. Engage manufacturer to provide technical supervision of installation of vibration control products.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. **Manufacturer:** Subject to compliance with requirements, provide vibration control products of one of the following:
 - 1. Amber/Booth Co.
 - 2. Korfund Dynamics Corp.
 - 3. Mason Industries, Inc.
 - 4. Peabody Noise Control, Inc.
 - 5. Vibration Eliminator Co., Inc.
 - 6. Vibration Mountings and Controls, Inc.

2.2 VIBRATION CONTROL MATERIALS AND SUPPORT UNITS

- A. **Vibration Isolation Springs:** Wound-steel compression springs, of high-strength spring alloy steel; with spring diameter not less than 0.8 of compressed height of spring at rated loads. Provide minimum additional travel to solid, equal to 50% of rated deflection. Provide spring wire with elastic limit stress exceeding stress at solid deflection.
- B. **Spring Isolators, Free-Standing:** Except as otherwise indicated, provide vibration isolation spring between top and bottom loading plates, and with pad-type isolator bonded

to bottom of bottom loading plate. Include studs or cups to ensure centering of spring on plates. Include leveling bolt with lock nuts and washers, centered in top plate, arranged for leveling and anchoring supported equipment as indicated.

1. Include holes in bottom plate for bolting unit to substrate as indicated.
- C. Spring Isolators, Vertically-Restrained: Provide spring isolators in housing that includes vertical limit stops. Design housing to act as blocking during erection, and with installed height and operating height being equal. Maintain 1/2-inch minimum clearance around restraining bolts, and between housing and springs. Design so limit stops are out of contact during normal operation.
1. Isolators exposed to weather shall be hot dipped galvanized.
- D. Fabricated Equipment Bases: Where supplementary bases are indicated for use with isolator units to support equipment (base not integral with equipment), provide welded rectangular unit, fabricated of structural steel shapes, plates and bars complying with ASTM A36, as shown. Provide welded support brackets and anchor base to spring isolator units. Except as otherwise indicated arrange brackets to result in lowest possible mounting height for equipment, but provide minimum of 1 inch. Provide bolt holes in base matching anchor bolt holes in equipment.
1. Fabricate base with depth of structure not less than $0.10 \times$ longest span of base, rigidly braced to support equipment without deflections or distortions which would be detrimental to equipment or equipment performance.
 2. Inertia Base Frames: Where inertia bases are indicated for use with isolation units to support equipment, provide rectangular structural beam channel, or complete sheet metal box concrete forms for floating foundations, with materials complying with ASTM A36. Frame unit with minimum depth of $0.08 \times$ longest dimension of base, but not less than 6 inch deep. Size frame so that weight of frame plus concrete fill will be greater than one- & one-half times the operating weight of equipment supported. Provide steel reinforcing both ways with both ends of reinforcing butt-welded to base framing.
 3. Provide anchor bolts, located as required for equipment anchorage and supported for casting of concrete. Locate bolts as indicated.
 4. Provide adjustable bolts in pipe sleeves; for minimum of 1/2-inch adjustment around anchor bolts.
- E. Isolation Hangers: Hanger units formed with brackets and including manufacturer's standard compression isolators of type indicated. Design brackets for 3 times rated loading of units. Fabricate units to accept misalignment of 15 deg. off center in any direction before contacting hanger box, and for use with either rod or strap type members, or including acoustical washers to prevent metal-to-metal contacts.
1. Provide neoprene element or spring securely retained in hanger box.
 2. Provide hangers, pre-compressed to rated load to limit deflection during installation. Design so hanger may be released after full load is applied.

- F. Flexible Pipe Connectors: Provide braided stainless steel type flexible pipe connectors.
- G. Flexible Duct Connections: Provide flexible duct connectors fabricated in accordance with SMACNA duct construction Standards. Flexible materials shall be rated for the temperatures, pressures, gasses conveyed, and atmospheric conditions indicated.
- H. Neoprene Pads: Oil-resistant neoprene sheets, of manufacturer's standard hardness and cross-ribbed or waffled pattern.

PART 3 EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which vibration control units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PERFORMANCE OF ISOLATORS

- A. General: Provide vibration isolation on all equipment connections and supports for all equipment with rotating components (motors, fans, compressors, etc...). Comply with minimum static deflections recommended by ASHRAE, for selection and application of vibration isolation materials and units as indicated.
- B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.3 APPLICATIONS

- A. General: Except as otherwise indicated, select vibration control products in accordance with the 1995 ASHRAE Applications Handbook, Chapter 43, Sound A Vibration Control, Table 42. Where more than one type of product is offered. Selection is installer's option.
- B. Piping:
 - 1. For piping connected to equipment mounted on vibration control products, install isolation hangers as indicated, and for first 3 points of support for pipe size 4-inch and less, for first 4 points of support for pipe sizes 5-inch through 8-inch.
 - 2. Provide braided stainless steel flexible pipe connectors at all unit connections. Flexible pipe connections shall generally be installed straight; however, a maximum of one single 90-degree bend may be provided if indicated as such on the drawings.

3.4 INSTALLATION

- A. General: Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration control materials and units. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.
- B. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.
- C. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.
- D. Install inertia base frames on isolator units as indicated, so that minimum of 1 inch clearance below base will result when frame is filled with concrete and supported equipment has been installed and loaded for operation. Provide concrete for inertia bases.
- E. For air handling equipment, install thrust restraints as indicated, and also wherever thrust exceeds 10 percent of equipment weight.
- F. Locate isolation hangers as near overhead support structure as possible.
- G. Weld riser isolator units in place as required preventing displacement from loading and operations.
- H. Flexible Pipe Connectors: Install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.

3.5 ADJUSTING AND CLEANING

- A. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated.
- B. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 23 sections apply to this Section: "Basic Mechanical Requirements."
- C. Related Sections: Other Division 23 Sections specify balancing devices and their installation, and materials and installations of mechanical systems.

1.2 SUMMARY

- A. This Section specifies the requirements and procedures for total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required meeting design specifications, and recording and reporting the results.
- B. Test, adjust, and balance the following mechanical systems:
 - 1. All new systems which are being including:
 - a. Supply air systems;
 - b. Return air systems;
 - c. Exhaust air systems;
 - d. Verify temperature and humidity control system operation.
 - e. Hot water system, boiler and flow.
 - f. Hot water pumps water flow.
 - g. Hot water pumps.
 - 2. Acoustical measurements
- C. This Section does not include:
 - 1. Specifications for materials for patching mechanical systems;
 - 2. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
 - 3. Requirements and procedures for piping and ductwork systems leakage tests.

1.3 DEFINITIONS

- A. Systems testing, adjusting and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:
 - 1. The balance of air distribution;
 - 2. Adjustment of total system to provide design quantities;
 - 3. Electrical measurement;
 - 4. Verification of performance of all equipment and automatic controls;
- B. Test: To determine quantitative performance of equipment.
- C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment e.g., reduce fan speed, throttling.
- D. Balance: To proportion flows within the distribution system submains, branches, and terminals according to specified design quantities.
- E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.
- F. Report forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.
- G. Main: Duct or pipe containing the system's major or entire fluid flow.
- H. Submain: Duct or pipe containing part of the systems' capacity and serving two or more branch mains.
- I. Branch main: Duct or pipe serving two or more terminals.
- J. Branch: Duct or pipe serving a single terminal.

1.4 SUBMITTALS

- A. Agency Data: Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below.
- B. Engineer and Technicians Data: Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.
- C. Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this project.
- D. Maintenance Data: Submit maintenance and operating data that include how to test, adjust, and balance the building systems. Include this information in maintenance data specified in Division 1.

- E. Sample Forms: Submit sample forms, if other than those standard forms prepared by the AABC are proposed.
- F. Sample Instruments: Submit two hydronic flow measuring gauges with all required associated hoses, fittings, documentation, and valve charts for the PGCPs field inspector and design engineer to field spot check final balanced flows of all types of hydronic balancing valves provided.
- G. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:
 - 1. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders.
 - 2. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
 - a. General Information and Summary
 - b. Air Systems
 - c. Hydronic System
 - d. Temperature Control Systems
 - e. Special Systems
 - f. Water Treatment System
 - 3. Report Contents: Provide the following minimum information, forms and data:
 - a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Engineer, and Project. Include addresses, and contact names and telephone numbers. Also include a certification sheet containing the seal and name, address, telephone number and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.
 - b. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC and NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.

- H. Calibration Reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

1.5 QUALITY CONTROL

A. Agency Qualifications:

1. Employ the services of an independent testing, adjusting and balancing agency meeting the qualifications specified below, to be the single source of responsibility to test, adjust, and balance the building mechanical systems identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.
2. An independent testing, adjusting, and balancing agency certified by National Environmental Balancing Bureau (NEBB) in those testing and balancing disciplines required for this project, and having at least one Professional Engineer registered in the State in which the services are to be performed, certified by NEBB as a Test and Balance Engineer.
3. An independent testing, adjusting, and balancing agency certified by Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one Professional Engineer registered in the State in which the services are to be performed, certified by AABC as a Test and Balance Engineer.

B. Codes and Standards:

1. NEBB: "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems."
2. AABC: "National Standards for Total System Balance".
3. ASHRAE: ASHRAE Handbook, 1999 HVAC Applications Volume, Chapter 36, Testing, Adjusting, and Balancing.

- C. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the Engineer and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

1.6 PROJECT CONDITIONS

- A. Systems Operation: Systems shall be fully operational prior to beginning procedures.

1.7 SEQUENCING AND SCHEDULING

- A. Test, adjust and balance the air systems before hydronic systems.
- B. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 5 deg F wet bulb temperature of maximum summer design condition, and within 10 deg F dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

- A. Before operating the system, perform these steps:
 - 1. Obtain design drawings and specifications including all addendums and revisions and become thoroughly acquainted with the design intent.
 - 2. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return, and exhaust) and temperature control diagrams.
 - 3. Compare design to installed equipment and field installations.
 - 4. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
 - 5. Check filters for cleanliness.
 - 6. Check dampers (both volume, smoke and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
 - 7. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.
 - 8. Determine best locations in main and branch ductwork for most accurate duct traverses.
 - 9. Place outlet dampers in the fully open position.
 - 10. Prepare schematic diagrams of system "As-Built" ductwork and piping layouts to facilitate reporting.
 - 11. Lubricate all motors and bearings
 - 12. Check fan rotation
 - 13. Test and balance, engineer shall witness and record all leakage testing of ductwork. Leakage test data shall be included in final test and balance reports.

3.2 MEASUREMENTS

- A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
- B. Provide instruments meeting the specifications of the referenced standards.
- C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.
- D. Apply instrument as recommended by the manufacturer.
- E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.
- F. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.
- G. Take all reading with the eye at the level of the indicated value to prevent parallax.
- H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.
- I. Take measurements in the system where best suited to the task.

3.3 PERFORMING TESTING, ADJUSTING, AND BALANCING

- A. Obtain approval from the Mechanical Specialist for the start date of onsite testing and balancing. Perform complete air balance when the building is complete.
- B. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.
- C. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
- D. Patch insulation, ductwork, and housings, using materials identical to those removed.
- E. Seal ducts and piping all around insulation seams air and water tight, and test for and repair leaks.
- F. Seal insulation to re-establish integrity of the vapor barrier.
- G. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.

- H. Retest, adjust and balance systems subsequent to significant system modifications, and resubmit test results.

3.4 TESTING AND BALANCING REPORT (TAB) CONFIRMATION OF DUCT LEAKAGE:

- A. The total system air leakage rate for the completed installation of each ductwork system shall not exceed three (3%) percent of the design air flow rate. The TAB report shall specifically document compliance with this requirement. If compliance is not achieved the contractor shall correct the deficiency by either correcting the construction work or implementing a remedial duct interior sealing methodology acceptable to the Engineer, then perform all TAB work again.

3.5 ACOUSTICAL MEASUREMENTS

- A. Provide ambient sound pressure level measurement of all spaces after acceptance of final balancing. Measure octave band sound pressure levels and A weighted sound pressure at the center of each space and at a height of 30 inches above the floor. Plot measurements on both an NC and RC chart and label with resulting value. Perform all testing work in compliance with Green building code, commissioning requirement.

3.6 RECORD AND REPORT DATA

- A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.
- B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

3.7 DEMONSTRATION

- A. Training:
 - 1. Train the Owner's maintenance personnel on troubleshooting procedures and testing, adjusting, and balancing procedures. Review with the Owner's personnel, the information contained in the Operating and Maintenance Data specified in Division 1 and Section 235010.
 - 2. Schedule training with Owner through the Engineer with at least 7 days prior notice.

END OF SECTION

SECTION 230783 MINI-SPLIT SYSTEM

PART 1 GENERAL

1.1 SUMMARY

- A. Extent of mini-split system cooling units work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of mini-split system cooling units specified in this section shall include wall mounted ductless and ducted split systems.
- C. Related Sections: The following sections contain requirements that relate to this Section.
 - 1. Provide the following electrical work of this section, in accordance with requirements of Division 26:
 - a. Provide control wiring between unit-mounted control panel and thermostats, remote control panels, and any other control device furnished as work of this section.
 - b. Provide factory-mounted and wired controls and electrical devices as specified in this section.
 - 2. Division 26 sections for other electrical work including motor starters, disconnects, wires/cables, raceways and other required electrical devices; not work of this section.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories; and installation and start-up instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to mini-split system cooling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of mini-split system cooling units and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Maintenance Data: Submit maintenance data and parts list for each mini-split system cooling unit, control, and accessory; including "trouble-shooting" maintenance guide.

Include this data and product data in maintenance manual; in accordance with requirements of Division 1.

- E. Reports: Submit a written report for each quality control test indicating all data. When applicable include the signature of the commissioning agent or inspection authority.

1.3 QUALITY CONTROL

A. Codes and Standards:

1. ARI Compliance: Provide capacity ratings for packaged heating and cooling units in accordance with ARI Standard 210 "Standard for Unitary Air-Conditioning Equipment."
2. ASHRAE Compliance: Construct refrigerating system of mini-split system cooling units in accordance with ASHRAE Standard 15 "Safety Code for Mechanical Refrigeration."
3. UL Compliance: Provide mini-split system cooling units which are UL-listed and labeled.
4. UL Compliance: Provide mini-split system cooling units which are designed, manufactured, and tested in accordance with UL requirements.
5. Energy Compliance: Provide compressor units with not less than minimum COP/Efficiency levels as prescribed in ASHRAE 90A "Energy Conservation in New Building Design" or as prescribed in state or local energy code, whichever is more stringent.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Handle mini-split system cooling units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged mini-split system cooling units or components; replace with new.
- B. Store mini-split system cooling units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with manufacturer's rigging and installation instructions for unloading mini-split system cooling units, and moving units to final location for installation.

1.5 SPECIAL PROJECT WARRANTY

- A. Warranty on Motor/Compressor: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, motors/compressors with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during

warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.

- B. Warranty Period: 5 years from Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Daikin (Basis of Design)
- B. Mitsubishi (Equivalent Products)
- C. Samsung (Equivalent Products)

2.2 SYSTEM DESCRIPTION

- A. The variable capacity, heat pump air conditioning or air conditioning system (as indicated on plans) shall be a split system. The system shall consist of a ductless wall mounted or ducted evaporator (as indicated on the drawings) exclusively matched to outdoor model direct expansion (DX), air-cooled, swing variable speed inverter driven compressor using R-410A refrigerant. The outdoor unit is a horizontal discharge air variable speed condenser fan using a single-phase power supply. The system shall have a self-diagnostic function, 3-minute time delay mechanism. The system shall have automatic restart capability after a power failure has occurred and a low voltage cut-off feature to prevent stalling during power supply issues. Provide a BACnet gateway for communication of room temperature setting, set point adjustment, operating status, and alarm status. Connect to BMS.

2.3 INDOOR UNIT

- A. General: The indoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. Both liquid and suction lines must be individually insulated between the outdoor and indoor units.
- B. Ductless Wall Mounted Unit Cabinet:
 - 1. The indoor unit shall have a white, “flat screen” finish.
 - 2. The drain and refrigerant piping shall be accessible from six (6) positions for flexible installation (right side, right back, and right bottom; and left side, left back, and left bottom).
 - 3. The cabinet shall be supplied with a mounting plate to be installed onto a wall for securely mounting the cabinet.

4. The cabinet includes an “intelligent-eye” motion sensor capable of setting back the set point temperature for energy savings. This feature may be disengaged on the wireless remote controller.
- C. Fan:
1. The evaporator fan shall be an assembly consisting of a direct-driven fan by a single motor.
 2. The fan shall be statically and dynamically balanced and operate on a motor with permanent lubricated bearings.
 3. An auto-swing louver for adjustable air flow (both vertically and horizontally) is standard via the wireless remote control furnished with each system.
 4. The indoor fan shall offer a choice of five speeds, plus quiet and auto settings.
- D. Filter: The return air filter provided will be a mildew proof, removable and washable filter. Titanium apatite, photocatalytic air purifying filters are included as standard
- E. Coil:
1. The evaporator coil shall be a nonferrous, aluminum fin on copper tube heat exchanger.
 2. All tube joints shall be brazed with silver alloy or phos copper.
 3. All coils will be factory pressure tested.
 4. A condensate pan shall be provided under the cooling DX-coil with a drain connection.
- F. Electrical:
1. The outdoor unit shall be powered with 208-230 volts, 1 phase, and 60 hertz power. The indoor unit shall receive 208-230 volt, 1 phase, 60 hertz power from the outdoor unit.
 2. The allowable voltage range shall be 187 volts to 253 volts.
- G. Control:
1. The unit shall have a backlit, wireless remote infra-red controller capable to operate the system. It shall have Automatic Operation, Dry Operation and Fan Only Operation.
 2. The controller shall consist of an On/Off Power switch, Mode Selector, Silent Button (for outdoor unit), Fan Setting, Swing Louver, 7-day Programmable Timer, On/Off Timer Setting, Temperature Adjustment, °C or °F Temperature Set Point Display, “Intelligent Eye” sensor and Powerful Operation.
 - a. On/Off switch powers the system on or off.
 - b. Mode selector shall operate the system in auto, cool, heat, fan or dry operation
 - iii. Silent operation shall lower the sound level of the outdoor unit by slowing the inverter driven fan speed.
 - c. Fan setting shall provide five fan speeds.

- d. Swing louver shall adjust the airflow (horizontal and vertical) blades.
 - e. 7-Day programmable timer shall allow up to 4 schedules per day for a maximum of 28 per week.
 - f. Temperature adjustment allows for the increase or decrease of the desired temperature.
 - g. Intelligent eye provides an infrared sensor which detects movement and adjusts the temperature by 3.6°F up or down depending on operating mode.
 - h. Powerful operation allows quick cool down or heating up in the desired space to achieve maximum desired temperature in the shortest allowable time period.
3. The remote control shall perform Fault Diagnostic functions which may be system related, indoor or outdoor unit related depending on the fault code.
 4. Temperature range on the remote control shall be 64°F to 90°F in cooling mode and 50°F to 86°F in heating mode.
 5. The indoor unit microprocessor has the capability to receive and process commands via return air temperature and indoor coil temperature sensors enabled by commands from the remote control.

H. Sound: Indoor unit sound levels shall not exceed:

COOLING MODE SOUND LEVEL (H/M/L) DB(A)	HEATING MODE SOUND LEVEL (H/M/L) DB(A)
47 / 45 / 40	47 / 44 / 38

*Values are measured approximately 3 feet away.

2.4 OUTDOOR UNIT (CU)

- A. General: The outdoor unit shall be specifically matched to the corresponding indoor unit. The outdoor unit shall be complete factory assembled and pre-wired with all necessary electronic and refrigerant controls.
- B. Unit Cabinet: The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
- C. Fan:
 1. The fan shall be a direct drive, propeller type fan.
 2. The motor shall be inverter driven, permanently lubricated type bearings, inherent.
 3. The fan shall be capable of operating in “silent operation” which lowers the outdoor fan speed in either cool, heat or auto modes.
 4. A fan guard is provided on the outdoor unit to prevent contact with fan operation.
 5. Airflow shall be horizontal discharge.

D. Coil:

1. The outdoor coil shall be nonferrous construction with corrugated fin tube.
2. Refrigerant flow from the condenser will be controlled via a metering device.

E. Compressor:

1. The compressor shall be a Daikin swing inverter driven compressor.
2. The outdoor unit shall have an accumulator and four-way reversing valve.
3. The compressor shall have an internal thermal overload.
4. The outdoor unit can operate with a maximum vertical height difference of 66 feet and overall maximum length of 100 feet without any oil traps or additional components.

F. Electrical:

1. The electrical power requirement is 208-230 volt, 1-phase, and 60 Hz power.
2. The voltage range limitations shall be a minimum of 187 volts and a maximum of 253 volts.
3. The outdoor shall be controlled by a microprocessor located in the outdoor and indoor units via commands from the infrared remote controller.
4. Dedicated EEV's shall be provided for capacity control during part load of the indoor unit.

G. Sound: Outdoor unit sound levels shall not exceed:

COOLING MODE SOUND LEVEL DB(A)	HEATING MODE SOUND LEVEL DB(A)
54	55

*Values are measured approximately 3 feet away.

PART 3 EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which mini-split system cooling units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF MINI-SPLIT SYSTEM COOLING UNITS

- A. General: Install mini-split system cooling units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical installer.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- C. Air-Cooled Condenser Piping: Refer to Division 232300 section "Refrigerant Piping". Connect liquid and suction piping to unit as indicated.
- D. Drain Piping: Connect unit drain to nearest indirect waste connection. Provide trap at drain pan; construct at least 1 inch deeper than fan pressure in inch of water.

3.3 FIELD QUALITY CONTROL

- A. General: Start-up mini-split system cooling units, in accordance with manufacturer's startup instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.4 SPARE PARTS

- A. General: Furnish to Owner, with receipt, the following spare parts for each packaged heating and cooling unit:
 - 1. One set of filters for each unit.

END OF SECTION

SECTION 230855 UVC APPLIANCE FOR AIR STREAM DISINFECTION

PART 1 GENERAL

1.1 QUALITY CONTROL

A. UL Compliance:

1. Comply with UL Standard 900 as applicable to listing of air filters.
2. Comply with UL 984 – Safety Standards for Hermetic Motor Compressors.
3. Comply with UL/C-UL under Category Code ABQK (Accessories, Air Duct Mounted), UL Standards: 153, 1598 & 1995 respectively.

B. DELIVERY, STORAGE, AND HANDLING

1. Store UVC fixtures in a clean, dry place and protect from weather and construction traffic. Handle UVC Fixtures carefully to avoid damage to components, enclosures and finish. Leave factory-shipping covers in place until installation is complete. Do not install any damaged components; instead replace them and return damaged components to equipment manufacturer.
2. Comply with manufacturers' installation instructions regarding wiring and testing and to the drawings and/or specification regarding exact fixture placement for proper energy distribution.

PART 2 PRODUCTS

2.1 UVC Appliances

- A. General:** Germicidal UVC Lamps, Housings and mounting structure shall be of the single-ended, T5 tube type and be factory assembled and tested. Each UVC appliance shall consist of a lamp, lamp socket, and conduit with lamp to power supply leads, and a power supply (ballast). The support structure shall consist of a variable length mounting strut and mounting brackets. The mounting strut shall be capable of mounting the ballast, support the lamp, and provide apertures for the conduit and lamp leads. It shall be constructed to withstand the environments of HVAC equipment. The system shall provide for unobstructed (360 degree) UVC irradiance of the air stream. As alternative, for lamps mounted along the length of the duct, lamps may be mounted to existing structure or support channels supplied by others.

B. MANUFACTURERS

1. BOD. UVDI Ultraviolet devices, Inc.
2. Sanuvox
3. Sterilaire

C. Power Supply

1. Power supplies shall be of a high Efficiency, high Frequency, high Power factor type with a universal input of 100 to 277 VAC, 50 to 60 Hz., matched to the lamp and designed to maximize radiance and reliability. They shall have four-wire lamp operation, rapid start, with pre-heat capability. They shall be UL Listed and labeled, and comply with FCC 47, Part 18, non-consumer limits requirements. The ballast shall be protected from failure in the event of end-of-lamp-life lamp failure. The ballast shall be capable of operation indefinitely when powered with no lamp or failed or broken lamp. The ballast shall have protection from a short circuit and over temperature protection with automatic reset. Each shall be capable of connection to a factory supplied mounting strut, equipped with a UL approved and NEC code compliant power connection, within a conduit, to the lamp. The power source shall maximize UVC, radiance and reliability and be UL listed for cold and/or moving air streams at temperatures ranging from 30° to 150° F and airflow velocities to 600 fpm.
2. The system shall allow for installation of the Power supplies within the struts or in a separate electrical enclosure outside the duct. For installations where support struts are not supplied the power supply shall be enclosed in a galvanized steel enclosure. Enclosure shall allow for easy mounting and connection terminal for input power.

D. Lamp Sockets: Sockets shall be constructed of UVC resistant, commercial grade HVAC materials designed for long service. The Lamp Socket shall accommodate a single ended four-pin, T5 diameter, 360° radiant lamp.

E. Lamp:

1. Lamps shall be a high output (nominal 825 milliamperes), T-5 diameter, hot cathode low pressure UVC lamp.
2. Lamp tubes shall be constructed of quartz or Sodium Barium glass and internally coated, designed to extend lamp life and maintain output. Quartz lamps shall be doped to prohibit 185 nm emissions and shall produce no ozone. Undoped quartz lamp tubes shall not be acceptable.
3. Polymer-sleeved lamps shall be provided.
4. Lamps shall be equipped with a four-pin single ended lamp base. Wires from the end opposite the base shall be Teflon coated and rated at 600 volts.
5. The lamp shall produce no less than 80% of its initial UVC output at “end of life.” Lamp life shall be a minimum of 9000 hours of service.
6. Each lamp shall contain no more than 8.0 milligrams of mercury.
7. Lamps shall produce a minimum of 90% of its energy at 254nm UV at up to 600 fpm air velocity in temperatures from 55° to 135° F without production of ozone at levels stated by the manufacturer. Performance cures of the lamp at operating temperatures and air velocity shall be supplied by the manufacturer as required.

8. Lamp performance shall be maintained with no more than a 20% output loss at the end of one year of continuous use.
- F. Support Structure: Support Structure shall consist of one or more metal struts that shall be mounted via brackets to the ceiling and floor of the plenum or duct. Struts shall contain integral wire ways and covers to allow connection of multiple fixtures to a single power supply lead. Support struts shall be adjustable to accommodate the plenum or duct height. Supports shall have knock-outs to provide for the mounting of the lamps, power supplies (ballast) and lamp connection conduit at multiple locations.
- G. Performance:
1. Each lamp appliance as submitted shall be independently tested to verify output under the variable operating conditions typically found in HVAC equipment.
 2. The UVC system shall be tested to verify performance and conformity to UL/C-UL standards included in UL Category Code ABQK (accessories, Air Duct mounted) Performance.
 3. Irradiation – Lamp appliance and support structure are to be installed allowing for multiple rows and in lamp lengths necessary to cover the full width of the duct or plenum. As alternative, lamp appliance and support structure can be installed as necessary to cover the length of the duct or plenum.
 4. When installed, the average irradiance throughout the moving air stream within the UV irradiation zone shall be sufficient to disinfect a specific micro-organism at a rate of 75% or higher upon the first pass. Additionally, a URV rating, as defined by the IUVA, shall be determined for first-pass disinfection in the installed location.
 5. The manufacturer shall provide irradiation, intensity, and UV dosage calculations or modeling to determine fixture placement, energy distribution, URV rating, and projected disinfection rates as required. Modeling results shall account for varying UV intensity in X, Y and Z planes throughout the airstream. UV System shall provide minimum dosage of 1940 uW/cm² for Airstream Disinfection.
- H. Warranty: All components shall be warranted to be free from defects for a period of one year. Lamps shall have a minimum of 80% of new lamp output at the end of 9000 hours.
- I. Acceptable Manufacturers: Ultra Violet Devices, Inc.; Altru-V products.
- J. Quality Control: UVC products shall be from an ISO 9001 manufacturer or the supplier shall provide proof of 100% inbound and outbound testing of equipment.

PART 3 EXECUTION

3.1 INSTALLATION OF UVC FIXTURE

- A. Coordinate with the installation of HVAC equipment as indicated above after such HVAC equipment is properly installed. Field install all UV fixtures per manufacturer's guidelines.
- B. Comply with the safety standards specified in the ASHRAE Handbook "Systems and Equipment," Chapter 60. At a minimum, provide a disconnect switch and a safety interlock switch on all access panels and doors leading to the UVC assembly and/or within view of the fixtures to assure that the UVC assembly will be de-energized when any of these accesses are opened.
- C. Install Caution Labels on all access doors and removable panels within sight of the Fixtures.
- D. Test operation of lamps and safety switches.

END OF SECTION

SECTION 230923 - DIRECT DIGITAL CONTROL SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION

- A. This is a retrofit of an existing BAS to add new terminal unit controls and integrate them into the existing BAS system network using open protocol controls. This specification for a Building Automation System (BAS) as detailed herein shall be strictly enforced. Provide a Building Automation System (BAS) incorporating BACnet Testing Laboratories (BTL) certified BACnet devices communicating over a Master-Slave Token Passing (MSTP) network at the field level and Niagara AX based network managers at the network TCP/IP level. The Niagara AX based network managers shall bridge the BACnet/MSTP field communications network to the owner's Local and/or Wide Area Network, as designated by the owner, and shall communicate seamlessly with the other Niagara AX based devices on the owner's city-wide BAS network. The BAS shall consist of Direct Digital Control (DDC) controllers, Building Controllers (BC), network management tools, programming tools, web browser based Graphical User Interface, sensors, relays, valves, actuators, and other equipment as may be necessary to provide for a complete and operational control system for the HVAC and other building related systems as described within these specifications.
- B. The system installed shall seamlessly connect devices other than HVAC throughout the building regardless of subsystem type, i.e., HVAC, lighting, and power systems devices should easily coexist on the same network channel without the need for gateways. BACnet components not supplied by the primary manufacturer of the BAS shall be integrated to share common software for network communications, time scheduling, alarm handling, and history logging.
- C. The documentation contained in this section and other contract documents pertaining to HVAC Controls is schematic in nature. The Contractor shall provide hardware and software necessary to implement the functions shown or as implied in the contract documents.
- D. System configuration and monitoring shall be performed via a PC-type computer. Under no circumstances shall the PC be used as a control device for the network. It can be used for storage of data.
- E. While the operator shall be able to remotely view, operate, and modify the BAS, the BAS shall operate completely at the local level and no function what so ever shall rely on any remote server or other remote device for operation. An operator workstation shall be provided on-site with computer, all required software, monitor, and printer to allow viewing of and controlling of all portions of the system. Trend log data shall reside locally.

- F. Licenses shall be provided to allow an unlimited number of local and remote connections to the BAS.

1.2 OPEN SYSTEMS DESIGN

- A. It is the owners expressed goal to implement an open Building Automaton System that will allow products from different manufacturers and/or suppliers to be integrated into a single unified system in order to provide flexibility for expansion, maintenance, and service of the system The BAS provided shall maintain open interoperability in the following areas.
- B. Communications - Provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet, , MODBUS, OPC, and other open communication protocols in one open, interoperable system. Where existing systems using proprietary protocols exist, a gateway or driver may be incorporated to provide for interoperability.
- C. Network Management - Network management tools shall be based upon Niagara Framework technology as developed by the Tridium Corporation. All tools and hardware provided shall comply with the current release of the AX Niagara Framework platform.
- D. User Access - The supplied system must incorporate the ability to access all data using standard Web browsers without requiring a proprietary operator/user interface and configuration programs. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access.
- E. Databases - All controller program graphics and network databases shall be provided in a Niagara Framework AX format. The database shall be stored on the owner PC and provide on a separate CD upon final acceptance of the project. An updated database shall be provided on a CD at the end of the warranty period.
- F. Building Controllers (BC) - All BC devices that provide for communication between the field level controllers and the owner's wide and/or local area network, and manage facility global functions such as alarms, trends, schedules and normalization of data shall conform to the current release of the Niagara AX Framework. All BCs shall be furnished with extended memory. No BC shall be provided with less than 128 MB of RAM. The number of BACnet attached to any Niagara AX based network manager shall not exceed the following limits:

COMBINED MEMORY	MAXIMUM NUMBER OF NODES
128 MB SDRAM/64 MB SERIAL FLASH	25
256 MB DDR RAM/128 MB SERIAL FLASH	50
1 GB DDR2 RAM/1 GB SERIAL FLASH	125

- G. Regardless of the maximum number of nodes indicated above, it is ultimately the exclusive responsibility of the systems integrator/building controls contractor to ensure that the BC has adequate resources for the number of nodes (controllers) attached to it.
- H. Niagara AX Network Manager Server software shall be furnished and installed on a server grade PC for applications requiring two or more network managers.
- I. Direct Digital Controllers (DDC) - All DDC devices for HVAC and lighting control, with the exception of DDC device furnished as part of the OEM control package, shall be provided by one manufacturer and shall be certified to the current BTL standards appropriate to their application provided an appropriate BTL Certification standard exist. All points within a controller including hard I/O and software-based points shall be available for viewing, management, and manipulation through the Niagara Framework tools.
- J. Product Access – All products provided shall be available for sell directly to the owner or is designated agent from multiple sources without restrictions on territory. A list of at least 3 purchasing sources shall be provided as part of the BAS submittals.
- K. Software Tools - All software tools needed for full functional use, including programming of BCs and DDC, network management and expansion, and graphical user interface development, of the BAS described within these specifications, shall be provided to the owner or his designated agent. Any licensing required by the manufacturer now and into the future, including changes to the licensee of the software tools and the addition of hardware corresponding to the licenses, to allow for a complete and operational system for both normal day to day operation and servicing shall be provided. Any such changes to the designated license holders shall be made by the manufacturer upon written request by the owner or his agent. Any cost associated with the license changes shall be identified within the BAS submittals.
- L. Programming Tools - Provide freely available Niagara AX Wizards to facilitate the programming and configuration of all of the DDC devices that are provided for the HVAC and lighting control. Wizards shall be provided free of charge and be compatible with the current published versions of the network management tool that is provided as part of this project. The wizard software shall be available for public access from the manufacturer’s web site. These wizard programming tools shall be compatible with at least 3 other brands of the Niagara Framework network management tools. The SI shall

demonstrate as part of their prequalification as to how they intend to comply with these requirements.

- M. Software License Agreement - The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights as it relates to disclosure of trade secrets contained within said software. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code, databases and documentation for all configuration and programming that is generated for a given project and/or configured for use with the BC, BAS Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner.
- N. The System Integrator shall provide as part of the submittals a copy of the Niagara Compatibility Statement (NiCS) verifying that all aspect of the Niagara Framework as provided maintain an Open System Design. The System as provided shall confirm with the following NiCS

Property	Value
STATION COMPATIBILITY IN	All
STATION COMPATIBILITY OUT	All
TOOL COMPATIBILITY IN	All
TOOL COMPATIBILITY OUT	All

- O. Training - Manufacturer provided training on the use and operation of all products provided within these specifications shall be available for purchase and attendance by the Owner or his designated agent. Such training shall be of the same curriculum as the training courses provided by the manufacturer to the System Integrator. A manufacturer advanced AX certified instructor shall give all training classes. A list of training courses and the associated cost shall be provided as part of the BAS submittals.

1.3 QUALITY CONTROL

- A. General - The HVAC Control System shall be furnished, engineered, and installed by a licensed Controls Contractor or System Integrator (SI). All work provided under this section shall be provided by direct employees of the SI or under the direct supervision of the SI personnel.
- B. System Integrator Qualifications:
 - 1. The SI must be regularly engaged in the service and installation of , BACnet, and Niagara AX based systems as specified herein, The SI shall have a minimum of 5

- years' experience in the sales, installation, engineering, programming servicing and commissioning of the Niagara^{AX} platform and the field controller as proposed
2. The system integrator must be an authorized factory direct representative in good standing of the manufacturer of the proposed hardware and software components. Provide a letter dated within the last 6 months, from the manufacture certifying that the System Integrator is an authorized factory direct representative.
 3. The SI shall have an office within 75 miles of the building site that is staffed with a minimum of five (5) technicians who have successfully completed the factory authorized training of the proposed manufactures hardware and software components and have successfully completed a Niagara AX certification course. SI must provide proof of required training. The SI capabilities shall include engineering and design of control systems, programming, electrical installation of control systems, troubleshooting and service.
 4. The SI shall submit a list of no less than three (3) similar projects, which have similar Building Automation Systems as specified herein installed by the SI. These projects must be on-line and functional such that the Owner's/User's representative can observe the system in full operation.

C. Hardware and Software Component Manufacturer Qualifications

1. The manufacturer of the hardware and software components must be primarily engaged in the manufacture of both BACnet based systems as specified herein, and must have been so for a minimum of three (3) years. The manufacturer shall demonstrate that they are the manufacturer of all DDC devices and Niagara AX products provided. Rebranded products manufactured by a different manufacturer are not acceptable.
2. The manufacturer of the hardware and software components as well as its subsidiaries must be a member in good standing of the BACnet International, and the BACnet Manufacturers Association.
3. The manufacturer of the hardware and software components shall have a technical support group accessible via a tollfree number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.
4. Acceptable manufacturer of the hardware and software components as specified herein: Siemens

1.4 SUBMITTALS

A. General

1. Meet all applicable Submittal requirements of Division 1 and other divisions where applicable, including listed below and in the Submittal check list.
2. Provide to the Engineer and Owner all information or data necessary to determine compliance with these specifications.

3. Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, including specific requirements indicated.
 4. All Drawings and Diagrams shall be machine-drafted using AutoCAD 2000 or later, or Microsoft Visio. At project closeout, provide vellum plots and diskette or CD copy of control drawings and layout drawings to the Owner.
 5. Provide system device and LAN conduit routing drawing, using building plans for a background. All controllers, gateways, hubs, devices and communication cabling shall be accurately shown, except that individual sensor I/O wiring and devices need not be shown. Layout drawings shall be the same size as the Engineer's construction documents.
- B. Hardware - Include a complete list of materials of equipment to be used, including technical data, performance curves, project specification sheets and installation/maintenance instructions.
- C. Control System Diagrams - Provide graphic schematic diagrams for each controlled system and device. Illustrate the relationship between control system and controlled equipment. Show all control elements. Show all terminations and cable/tube numbers.
1. Provide equipment interface details using actual equipment termination information. Blank terminals or "field verify" is not acceptable.
 2. Provide individual diagrams for each mechanical system and each and every piece of equipment.
 3. The control diagrams and sequence of operation shall be together on the same sheet and shall be suitable for posting.
 4. The sequence of operation shall reference a schematic diagram of the controlled system. The sequence of operation shall describe in words the control strategies utilized, worded in such a way to serve as an informative reference to the maintenance and service personnel who will be responsible for unit operation.
 5. Each component and instrument on the control diagrams shall have a unique tag number such as temperature element "TE-1". The sequence of operation verbiage shall make specific reference to the individual component tag numbers, such as "Controller (C-1) compares the space temperature sensor (TE-1) to set point, and modulates hot water heating coil valve (V-1) as required". The mechanical system being controlled shall be schematically drawn and show the measurement and control points, such as "TE-1" and "V-1".
- D. Graphic Displays - Include draft copies of BAS computer graphic displays in the submittal package indicating mechanical system components, control system components, and controlled function status and value.
1. Graphics shall be dynamic and shall visually indicate the operating status of components, including but not limited to the following:
 - a. Fan wheels shall rotate when on.
 - b. Pumps shall show a rotating impeller (or similar feature) when on.
 - c. Dampers shall stroke to an open, closed, or partially open position.

- d. Valve position shall be indicated.
2. Provide a floor plan for the complete building indicating the following:
 - a. Room thermostat locations
 - b. Room heating and cooling setpoints.
 - c. Actual room temperatures.
3. Graphic shall be color coded to indicate:
 - a. Normal operating status (on).
 - b. Normal off status.
 - c. Failure or alarm status.
4. All graphics shall be coordinated with the actual equipment being provided. Generic graphics or images that do not exactly match the provided equipment are not acceptable.
- E. Point List - Provide a point list for each system controller including both inputs and outputs (I/O) point, point number, the controlled device associated with the I/O point and the location of the I/O device. Use naming convention consistent with control diagrams and sequence of operation.
- F. Software manuals - Include software manuals that describe programming, testing, system overview. The manuals shall include a detailed description of each software feature including editing and writing control programs, reading or modifying printout and logs, adding, deleting and modifying user password, creating and modifying graphics. Software manuals may be provided on CD ROM in lieu of paper copy. If submitted as a CD ROM, the vendor shall arrange to review the software manuals with the engineer at the engineer's office.
- G. Other Items Requiring Submittals
 1. Point to point and basic function commissioning forms to be used on site for the start, test and check of network components and systems.
 2. List of specific personnel who will be involved in the system installation and commissioning.
 3. Functional performance test documentation and procedures to be used in commissioning control sequences.
- H. Operation and Maintenance Manuals shall be submitted indicating the correct procedures and processes to operate and maintain the system. O&Ms shall be delivered either hard copy or on a CD-ROM developed specifically for the project. Contractor shall submit (3) copies of the Operation and Maintenance Manuals.
- I. Parts List shall be submitted listing: manufacturer's name, part number, nomenclature, and stock level required for maintenance and repair necessary to ensure continued operation with minimal delay.

- J. Reports: Submit a written report for each quality control test indicating all data. When applicable include the signature of the commissioning agent or inspection authority.
- K. Submittal Check List - The following Submittal Check list is intended to provide the SI, Consulting Engineer and Owner with a working document upon which to verify compliance with the major portions of the specification that can more easily be verified through printed documentation. It in no way excludes the SI from compliance or for verification of compliance of any portion of this specification.

Submittal Check List

Section	Description	Rejected	Approved	Comments	Project Acceptance Submittal
1.2	Open System Design				
1.2B	Niagara Framework Network Management Tool and hardware AX version				
1.2D	Provide Database on CD				
1.2G	Verify all controllers are BTL certified and from one manufacture. Provide XIF file or PIC Statement to verify exposure of all points and or Objects.				
1.2I	Provide evidence of what Software tools will be provided				
1.2I	Software tools license change cost				
1.2L	Software Licensing NiCS				
1.2M	Training – provide list of training courses and cost				
1.3B1	Provide evidence of 3 years in the controls business				
.3B2	Provide evidence of authorized representative of approved BAS manufacturer				

1.3B3	Provide office location, names of 2 technicians and certificate of training certification				
1.3B4	Provide list of 3 projects				
1.4A, B, C	Provide control drawings				
1.4D	Provide graphics in draft form				
1.4E	Provide points list				
1.4F	Provide software manuals				
1.4G1	Provide Commissioning forms				
1.4G2	Provide a list of personnel for install and commissioning				
1.4G3	Provide Functional performance test documentation				
1.4H	Provide Operational & maintenance manuals				
1.4I	Provide Parts List				
1.5	Provide required training materials				
1.6	Provide Verification of warranty of 12 months				
4.1	Provide verification that all configuration tools are provided as Niagara Framework AX Wizards				

1.5 TRAINING

- A. Meet all applicable Training requirements of Division 1, Division 23, and the following.
 - 1. Instruct the operators how to accomplish control of the system. Include basic troubleshooting and override of equipment and controls in the event of system failure.
 - 2. Training Allowance: Provide not less than 24 hours formal training to the Owner’s designated operations personnel. Two different levels of training classes

shall be provided, one specific for Building Operators, and one specific to Programming (for EMS staff).

3. Building Operator Training:
 - a. Prepare a course for a minimum of 8 hours of training to be conducted in two sessions. Provide training materials a minimum of two weeks ahead of the scheduled class dates for operators to study the material before attending the training.
 - b. Repeat this training course approximately six months later. this will allow for training of newly assigned staff and reinforcement of subject matter for persons who had previously attended the class.
 4. Programmers / Energy Management Staff Training: Prepare a course for a minimum of 8 hours of training to be conducted in two sessions. Provide training materials a minimum of two weeks ahead of the scheduled class dates for programmers to study the material before attending the training.
- B. Trainers - Persons conducting the training shall hold an advanced Niagara AX certification, be knowledgeable in the workings of the system, and shall be regularly engaged in training exercises, so as to provide effective training. Acceptability of the trainers shall be at the discretion of the Owner.
- C. Training Manuals - Include the following in training manuals.
1. Manufacturer's Training Brochures.
 2. Operation and Maintenance Manuals.
 3. Completed Field Acceptance Test Procedure.
 4. "As-installed" Drawings.
 5. Manufacturer's Operation Manuals.
 6. Software interaction sheets to be used in instructing students how to use the control system, on a command-by-command basis.
- D. Training Classes - Prior to conducting training, prepare and submit for approval the proposed training literature and topics. Submit this information at least two weeks prior to the first class.
- E. Provide approved training manuals to the Owner at least two weeks prior to the first class.
- F. Provide Audio Visual Tutorials both in a CD format and on the manufactures website instructing on the operation of the programming software tools as provided under this specification.

1.6 WARRANTY

- A. The HVAC Control System shall be free from defects in workmanship and material under normal use and service. If within twenty-four (24) months from the date of substantial completion, the installed equipment is found to be defective in operation,

workmanship or materials, the building systems contractor shall replace, repair or adjust the defect at no cost. Service shall be provided within 4 hours upon notice from Owner's designated Representative.

- B. The warranty shall extend to material that is supplied and installed by the Contractor. Material supplied but not installed by the Contractor shall be covered per the above to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation.
- C. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.

1.7 NETWORK ARCHITECTURES AND DEVICES

- A. NETWORKS – All Niagara AX based network managers supplied under this section shall bridge the , BACnet or ModBus field bus to the owner's Local Area Network (LAN) and/or Wide Area Network (WAN) as designated by the owner. The network managers shall communicate at no less than 100 Megabits/sec over the Ethernet network and shall support BACnet over IP, Java, XML, HTTP, Fox and SOAP for maximum flexibility as it relates to the integration of building data with enterprise information systems. The system shall provide support for multiple network managers, Building Controllers (BC), user workstations and, if specified, a local server. The WAN and/or LAN will be provided by others. The SI shall coordinate with the General Contractor for the access to the WAN and/or LAN.
- B. Network minimum physical and media access requirements:
 - 1. Ethernet; IEEE standard 802.3
 - 2. Cable; 100 Base-T, UTP-8 wire, category 5 Minimum throughput; 100 Mbps
- C. Network Access - Remote Access - For Local Area Network installations; provide access to the WAN and/or LAN from a remote location, via the Internet. The Owner shall provide a connection to the Internet to enable access via high-speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). The Owner agrees to pay monthly access charges for connection and ISP.

- 1.8 NETWORK FIELD LEVEL CONTROLLERS – The communication network between the field level controllers shall be TP/FT 10 bus topology, BACnet MSTP, BACnet/IP, Modbus RS-485 or Modbus/IP. All wiring shall be provided in accordance with the standards for the appropriate protocol. The number of devices on any one network shall not exceed 90% of capacity.

1.9 NETWORK MANAGEMENT DEVICES

- A. These various devices will service multiple functions on the network depending on network design, communication medium and needed task. These functions can include: management of traffic on the network, reconfiguring and strengthening of signals, the conversion of protocols, normalizing of data, global management of alarms, trends and schedules, control logic, protocol conversion and web page hosting for use as a Graphical User Interface.
- B. Building Controller (BC) – This Niagara Framework based device shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the BC.
1. It shall be provided with these features:
 - a. Web page hosting
 - b. Extended memory
 - c. Network management tools resident within the BC (optional)
 - d. Appropriate hardware and driver(s) associated with the protocol it manages
 - e. Din rail mounted power supply
 2. Provide multiple Building Controllers as necessary. In order to maintain peak performance of the network, limit the maximum consumed resources to 80 percent as indicated by the resource meter resident in the network management tools.
 3. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc. Manage alarms as defined in the points list.
 4. Provide timed (schedule) routing of alarms by class, object, group, or node.
 5. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control. Control equipment and network failures shall be treated as alarms and annunciated.
 6. Alarms shall be annunciated in any of the following manners as defined by the user:
 - a. Screen message text
 - b. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
 - c. Day of week
 - d. Time of day
 - e. Recipient
 - f. Pagers via paging services that initiate a page on receipt of email message
 - g. Graphic with flashing alarm objects
 - h. Printed message, routed directly to a dedicated alarm printer
 7. The following shall be recorded by the BC for each alarm (at a minimum):
 - a. Time and date

- b. Location (building, floor, zone, office number, etc.)
 - c. Equipment (air handler #, access way, etc.)
 - d. Acknowledge time, date, and user who issued acknowledgement.
 - e. Number of occurrences since last acknowledgement.
 - f. Alarm actions may be initiated by user defined programmable objects created for that purpose.
 - g. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
 - h. A log of all alarms shall be maintained by the BC and/or a server (if configured in the system) and shall be available for review by the user.
 - i. Provide a “query” feature to allow review of specific alarms by user defined parameters.
 - j. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
 - k. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.
8. Data Collection and Storage - The BC shall collect data for any property of any object and store this data as defined in the points list.
 9. The data collection shall be performed by log objects, resident in the BC that shall have, at a minimum, the following configurable properties:
 10. Designating the log as interval or deviation.
 11. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 12. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 13. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 14. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
 15. Audit Log - Provide and maintain an Audit Log that tracks all activities performed on the BC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the BC), to another BC on the network, or to a server. For each log entry, provide the following data:
 - a. Time and date
 - b. User ID
 - c. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
- C. BACnet Routers and Repeaters – A router or repeater may be used on a a BC as a means to manage traffic and reconfigure and strengthen a transmission signal. Routers shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing . A repeater or signal

booster may only be used to increase the signal strength of the communications. Under no circumstances may it be used in the place of a router.

D. Server Functions and Hardware – Provide a Personal Computer server along with the Niagara Framework Network management tools and server software, unlimited connectivity version. The server shall support all BCs connected to the customer's network whether local or remote. It shall be possible to provide access to all BC via a single connection to the server. In this configuration, each BC can be accessed from a remote Graphical User Interface (GUI) or from a standard Web Browser Interface (WBI) by connecting to the server. The server shall provide the following functions, at a minimum:

1. Global Data Access: The server shall provide complete access to distributed data defined anywhere in the system.
2. Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any BC in the network, local or remote.
3. The server shall include a master clock service for its subsystems and provide time synchronization for all BCs.
4. The server shall provide scheduling for all Network Area Controllers and their underlying field control devices.
5. The server shall provide demand limiting that operates across all BCs. The server must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.
6. Provide for browser based graphical home screen with links to each connected BC. See graphic section for additional details.
7. The server shall provide central alarm management for all BC supported by the server. Alarm management shall include:
 - a. Routing of alarms to display, printer, email and pagers
 - b. View and acknowledge alarms
 - c. Query alarm logs based on user-defined parameters
8. The server shall provide central management of log data for all BCs supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:
 - a. Viewing and printing log data
 - b. Exporting log data to other software applications
 - c. Query log data based on user-defined parameters

E. Server Hardware Requirements: The server hardware platform shall have the following requirements: NOTE: Update to Owner standards or latest industry standard performance levels for a PC server.

1. The server shall have a 500-gigabyte minimum hard drive, a 64-bit dual-core processor with 2.66 minimum processing speed, and 8 GB of RAM. It shall

- include a DVD-ROM/CD-RW Combination Drive, 2-parallel ports, 2-asynchronous serial ports, 2 Ethernet ports, and 2-USB ports.
2. The server operating system shall be provided with latest Microsoft Windows Operating Systems server based software that corresponds to the currently support version of the Niagara Framework and browsers as well as
 3. the latest version of Symantec Antivirus Software including a one year upgrade subscription service to the Symantec software.
 4. Connection to the FMCS network shall be via high a high-speed Ethernet network interface card, minimum 100 Mbps.
 5. A system printer shall be provided. Printer shall be laser type with a minimum 600 x 600-dpi resolution and rated for 60-PPM print speed minimum.

1.10 BUILDING AUTOMATION SYSTEM CONTROLLERS

- A. ALL CONTROLLERS: Shall be designed for easy installation and servicing including removable enclosures, removable terminals, and factory applied labels for all I/O. All internal points within the Programmable Controllers shall be fully supported by the Graphical User Interface (GUI), allowing the user to easily modify them and monitor them. All of the internal programming points (e.g., variables, constants, PID's, timers, inputs and outputs) shall be exposed to the network on dedicated network variable outputs. All controllers' programs and schedules shall contain non-volatile flash memory. Upon a loss of power all controllers shall perform a self-restart.
- B. PROGRAMMABLE CONTROLLERS (PC) – A controller designed for more complex sequences of operations such as built-up AHU, central plant operations, electrical monitoring, and control and management for boiler and generators. The PCs are to allow for the flexibility of custom control programming to meet the needed sequences of operation.
- C. Performance – Each PC shall have a minimum of 64K of Non-volatile Flash memory for control applications and 128K non-volatile flash memory for storage with a minimum 32-bit processor. The PC shall have a minimum ambient operating temperature range of -0°C to 70°C or 32°F to 158°F.
- D. Inputs – Analog inputs shall have the following minimum level of performance: 16-bit A to D resolution; allow monitoring of platinum 100 ohms, platinum 1000-ohm, nickel 1000 ohms, thermistor 10K type II, thermistor 10K type III, voltage input 0-10VDC, current input 4-20mA, digital input, pulsed input minimum 2 Hz.
- E. Outputs – Outputs shall be either software configurable to be either analog or digital or dedicated digital only - Analog outputs shall be selectable as voltage of 0-10 VDC (linear) or 4-20mA or Digital outputs shall be 0-12 VDC (off/on), floating or PWM. Outputs shall have an adjustable range of 2 seconds to 15 minutes. Output Resolution shall be a minimum 10 bit digital / analog converter. All individual outputs and power supply shall be protected by an auto reset fuse. There shall be an LED status indicator on each of the outputs.

1.11 PANEL-BASED PROGRAMMABLE CONTROLLERS –

- A. Shall be provided with a color operator interface that provides real-time access to monitored inputs, setpoints, modes, values, statuses, and outputs. The operator interface shall consist of:
- B. An icon-based, interactive backlit color display.
- C. A turn and select navigation jog dial to access, edit, and modify internal controller functions. The jog dial shall be used to navigate through menus, select options and icons, and change parameters. Scroll buttons (up, down, left and right) shall not be acceptable.
- D. Navigable menus to display, select, edit, and modify values and other controller information.
- E. List-based menus with a minimum of eight (8) lines of text.
- F. Icon-based menus.
- G. A display with the following minimum characteristics: a resolution of 400 W x 240 H pixels (WQVGA) with an effective viewing area of 2.4" L x 1.4" H (61.2mm x 36.7 mm), and 2.8" (71mm) diagonal viewing area.
- H. The operator interface shall use color-codes with icons and text lists to indicate values and controller statuses.
- I. The operator interface shall, at a minimum, have the following functions:
- J. Points. The operator interface shall provide points list menus to view the inputs, setpoints, and output values such as hardware inputs/outputs, analog values, binary values, multistate values, Intelligent Space Sensor (ISS) inputs, and wireless inputs.
- K. The points list menus shall allow the operator to monitor, set, and override controller points and values.
- L. A color-code shall be used to indicate the conditions and statuses of points displayed in the points list menus.
- M. Alarms. The operator interface shall provide a controller's alarms menu to view details of an alarm, to acknowledge the alarm, and to view the alarm history.
- N. The alarm menu shall allow the operator to view the following type of alarms: active not acknowledged, active acknowledged, and inactive not acknowledged.
- O. The combination of an icon and its color state shall notify the operator of an alarm condition.

- P. The operator shall be able to select a single point in alarm to view further details such as the alarm to/from status, current status, event date and time, alarm event threshold, and alarm event value.
- Q. Overrides. The operator interface shall provide an overrides menu to view a list of the controller's overridden points such as hardware input, hardware output, value, constant, or variable. The menu shall allow the operator to select an overridden point and to modify or release the override on the selected point.
- R. PID loops. The operator interface shall provide a PID Loops menu to view, configure, and adjust the PID parameters. The interface shall also provide visual PID tuning with live system response graphing (live-trend).
- S. The operator interface shall support Latin-based languages and allow the interface user to select from three (3) defined languages.
- T. The operator interface shall allow personalization of a contact information screen with a minimum of eight (8) lines of user configurable text as well as the option to add a color graphic such as a company logo. The tool shall support, but not be limited to, image file formats such as GIF, PNG, JPG, etc.
- U. Favorites. The operator interface shall allow access to a list of bookmarked points.
- V. Weather. The operator interface shall provide a weather menu to view the current weather conditions with a weather status icon. The units shall be configured to be displayed in either metric or US units.
- W. Password protected. The controller operator interface shall provide multi-level password protection, with user-defined, alphanumeric, name/password combinations. The operator interface shall return to lock mode after a user-defined log-off delay. A password icon shall indicate the lock mode state.
- X. Settings. The operator interface shall provide a settings menu to view and configure date and time parameters such as the current time, time zone, and daylight savings time.
- Y. Enclosures – Provide for a plastic enclosure with a separate back plate with terminals such that the electronic portion of the controller can be easily removed for ease of installation and servicing.

PART 2 BAS SOFTWARE TOOLS

- 2.1 Provide 6 copies of all tools necessary for the development, maintenance, expansion and use of the BAS described within these specifications. All software tools shall part of the Niagara Framework tools or be provided as Wizards that operates within the Niagara Framework environment. For the purpose of this specification software tools shall be divided into the following categories and meet these specified requirements.
 - A. Controller Programming Software

1. Provide Wizards or objects that facilitate the programming and configuration of the Configurable Controllers, Programmable Controller (PC) and or the Special Purpose Configurable Controllers (SPCC) sequence of operation through menu driven wizard. The programming tools shall perform the following functions:
 - a. Programmable controller programming shall be accomplished by graphical programming language (GPL) where objects are used to define different portions of the control sequence. All control sequences programmed into the PC shall be stored in non-volatile memory. Systems that only allow selection of sequences from a library or table are not acceptable. All code must be exportable to a library for future use.
 - b. Configurable Controller and Special Purpose Configurable Controller – Provide for the programming of the required sequence of operation through an intuitive configuration menu driven selection process. The configuration tools menu shall define items such as I/O configurations, set point, delays, PID loops, optimum start stops, and network variables settings. The configuration tool must indicate the device status and allows system override. Graphical programming language as described for the PC is acceptable.

- B. Network Management – (Disregard if software already in place) Provide one copy of the latest version of the Niagara Framework network management tool (unlimited connectivity version). Provide for the installation of the tools on the customer provided Personal Computer or server.

PART 3 USER INTERFACES

3.1 THE GRAPHICAL USER INTERFACE (GUI)

- A. Shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

- B. Provide a visual graphical representation of each piece of mechanical equipment and/or mechanical system that duplicates the represented system, where applicable. Graphics shall include at a minimum the value of each input, each output, each setpoint, alarms and graphical representation of trend logs. The graphic shall provide for the ability to command each point, including both timed and permanent overrides. In addition, provide for all information represented in the graphics in an associated graphical table with links to the equipment graphics and command able points. All graphics shall commiserate with latest industries standards and practices. Sample graphics shall be provided as part of the submittals for approval by owner.

- C. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:
1. Graphic screens shall be developed using any drawing package capable of generating or assembling objects from a GIF, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
 2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URLs, and links to other graphic screens.
 3. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
 - a. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - b. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 4. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 5. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.
- D. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:
1. Create, delete or modify control strategies.
 2. Add/delete objects to the system.
 3. Tune control loops through the adjustment of control loop parameters.
 4. Enable or disable control strategies.
 5. Generate hard copy records or control strategies on a printer.
 6. Select points to be alarm-able and define the alarm state.
 7. Select points to be trended over a period of time and initiate the recording of values automatically.
- E. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.
- F. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict

the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

- G. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
- H. Alarm Console
 - 1. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
 - 2. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.
- I. End User Dashboard Clients (Not Used)

3.2 WEB BROWSER CLIENTS

- A. Provide for a series of browser accessible graphical screens that are resident on the BC and Server that represent the systems controllers and managed by that BC and its associated controllers.
- B. The Web browser client shall support at a minimum, the following functions:
 - 1. User log-on identification and password shall be required. If unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - 2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 - 3. HTML programming shall not be required to display system graphics or data on a Web page
 - 4. Storage of the graphical screens shall be in the Building Controller (BC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - 5. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.

6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 - 1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - 2) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 - b. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 - c. View logs and charts
 - d. View and acknowledge alarms
7. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

PART 4 PERIPHERAL DEVICES

4.1 DAMPERS

A. Motorized dampers, unless otherwise specified elsewhere, shall be as follows:

1. Damper frames shall be 13-gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.
2. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16 gauge.
3. Secure blades to 1/2-inch diameter zinc-plated axles using zinc-plated hardware. Seal off against spring stainless steel blade bearings. Provide blade bearings of nylon and provide thrust bearings at each end of every blade. Construct blade linkage hardware of zinc-plated steel and brass.
4. All blade edges and top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide Leakage Class 1-A (3 cfm/square foot at 1 inch-w.g. (class 1A is only defined at 1 inch-wg) and Leakage Class 1 (rate of 8 CFM per square foot at 4" w.c. differential pressure when damper is being held by torque of 7.0 inch-pounds per square foot).
5. All leakage testing and pressure ratings will be based on AMCA Publication 500-D.

6. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.
- B. Control dampers shall be parallel or opposed blade types. Provide parallel blades for on/off service. Provide opposed blades for modulating service.

4.2 ACTUATORS

- A. Electronic damper/valve actuators.
 1. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
 2. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.
 3. All rotary spring return actuators shall be capable of both clockwise or counter clockwise spring return operation. Linear actuators shall spring return to the retracted position.
 4. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.
 5. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 W for DC applications. Actuators operating on 120 VAC or 230 VAC shall not require more than 11 VA.
 6. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.
 7. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation
 8. Actuators shall be provided with a conduit fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
 9. Actuators shall be Underwriters Laboratories Standard 873 listed.
 10. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque.

4.3 CONTROL VALVES

- A. Control Valves
 1. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown.
 2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - a. Water Valves:
 - 1) Two-way: 300% of total system (pump) head.

- 2) Three-way: 300% of pressure differential between ports A and B at design flow or 300% of total system (pump) head.
3. Water Valves:
 - a. Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown (but in compliance with the following), with equal percentage ports for modulating service, with rangeability of 50 to 1.
 - 1) Single Seated Valves: Cage type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
 - 2) Double Seated Valves: Balanced plug type, with cage type trim providing seating and guiding surfaces on "top and bottom" guided plugs.
 - 3) Valve Trim and Stems: Polished stainless steel.
 - 4) Packing: Spring-loaded Teflon, self-adjusting.
 - b. Sizing Criteria:
 - 1) Two-position service: Line size.
 - 2) Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 2.5 psi, whichever is less.
 - 3) Three-way Modulating Service: Pressure drop equal to twice the pressure drop through the coil exchanger (load) with 2.5 psig maximum.
 - 4) Valves 1/2" through 2" shall be bronze body or cast brass ANSI Class 250, spring loaded, Teflon packing, quick opening for two-position service. Two-way valves to have replaceable composition disc, or stainless-steel ball.
 - c. 2-1/2" valves and larger shall be cast iron ANSI Class 125 with guided plug and Teflon packing.
 - d. Water valves shall fail normally open or closed as scheduled on plans or as follows:
 - 1) Heating coils in air handlers - normally open.
 - 2) Chilled water control valves - normally closed.
 - 3) Other applications - as scheduled or as required by sequence of operation.
 - e. Zone valves shall be sized to meet the control application and they shall maintain their last position in the event of a power failure.

4.4 SENSORS

A. Temperature Sensors:

1. Temperature sensors shall be Resistance Temperature Device (RTD) or Thermistor.
2. Duct sensors shall be rigid or averaging as shown. Averaging sensors shall be a minimum of 1.5m [5 feet] in length.
3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
4. Space sensors shall be equipped with set-point adjustment, override switch, display, and communication port. Provide a space temperature sensor for every unit requiring such control whether indicated on the drawings or not.
5. Provide matched temperature sensors for differential temperature measurement. Differential accuracy shall be within 0.1 C [0.18 F].
6. The space temperature, setpoint, and override confirmation will be annunciated by a digital display for each zone sensor. The setpoint will be selectable utilizing buttons.

B. Humidity Sensors

1. Duct and room sensors shall have a sensing range of 20% to 80% with accuracy of $\pm 5\%$ R.H.
2. Duct sensors shall be provided with a sampling chamber.
3. Outdoor air humidity sensors shall have a sensing range of 20% to 95% R.H. It shall be suitable for ambient conditions of -40 C to 75 C [-40 F to 170 F].
4. Humidity sensor's drift shall not exceed 1% of full scale per year.

C. Static Pressure Sensors:

1. Sensor shall have linear output signal. Zero and span shall be field-adjustable.
2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.
3. Water pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Sensor shall be complete with 4-20 ma output, required mounting brackets, and block and bleed valves. Mount in location accessible for service.
4. Water differential pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (DP) and maximum static pressure shall be 3,000 psi. Transmitter shall be complete with 4-20 ma output, required mounting brackets, and five-valve manifold. Mount in a location accessible for service.

D. Low Limit Thermostats:

1. Safety low limit thermostats shall be vapor pressure type with an element 6m [20 ft] minimum length. Element shall respond to the lowest temperature sensed by any one-foot section.
2. Low limit shall be manual reset only.

- E. Flow Switches: Flow-proving switches shall be differential pressure type with adjustable sensitivity.
- F. Relays:
 - 1. Control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application.
 - 2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 Type enclosure when not installed in local control panel.

4.5 TRANSFORMERS

- A. Transformers And Power Supplies:
 - 1. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.
 - 2. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.
 - 3. Unit shall operate between 0 C and 50 C.
 - 4. Unit shall be UL recognized.
 - 5. Provide TVSS on all power supplies.

4.6 CURRENT SWITCHES

- A. Current Switches: Current-operated switches shall be self-powered, solid state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

4.7 LOCAL CONTROL PANELS

- A. Local Control Panels:
 - 1. All indoor control cabinets shall be fully enclosed NEMA 1 Type construction with [hinged door], key-lock latch, and removable sub-panels. A single key shall be common to all field panels and sub-panels.
 - 2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600-volt service,

individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.

3. Provide on/off power switch with over-current protection for control power sources to each local panel.

PART 5 SCHEDULE OF RESPONSIBILITIES

- A. The following schedule identifies the responsible Division for the installation of the building automation system. This schedule should be used as a general guide. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Architect.

Item		Furnish By	Install By	Power By	Control Wiring By
1.	Equipment Motors	M	M	E	
2.	Magnetic Motor Starters:				
	a. Automatically controlled, with or without HOA switches =	E	E	E	M
	b. Manually controlled.	E	E	E	M
	c. Manually controlled, and which are furnished as part of factory wired equipment.	M	M	E	
	d. Special duty type (part winding, multi-speed, etc.)	M	See Note 1.	E	See Note 1.
	e. Variable frequency drives with manual bypass.	SI	M	E	SI See Note 2.
	f. Domestic booster pump. Motor Controls	M	M	E	SI
3.	General equipment disconnect switches, thermal overload switches, manual operating switches.	E	E	E	□
4.	Sprinkler system water flow and tamper switches.	M	M	E	□
5.	Outside fire alarm horn and light (at Siamese connection).	M	M	E	□
6.	Line voltage contactors.	E	E	E	E

**MARYLAND STATE POLICE TACTICAL SERVICES
OPERATIONS & COMMAND BUILDING**

Project No: PA-75-210-001

	Item	Furnish By	Install By	Power By	Control Wiring By
7.	Control relay transformers (other than starters).	SI	SI	E	SI
8.	Main fuel oil tank alarms (high and low level) and remote indicating lights.	M	M	SI	SI
9.	Day tank fuel oil alarms (high and low level) and remote indicating lights.	E	E	E	SI
10.	Line voltage control items such as line voltage thermostats not connected to control panel systems.	M	SI	SI	SI
11.	Loose controls and instruments furnished as part of the packaged mechanical equipment or required for operation such as valves, float controls, relays, sensors,	M	M	E	—
12.	Control and Instrumentation panels	SI	SI	E	SI
13.	Automatic control valves, automatic dampers and damper operators, solenoid valves, insertion temperature and pressure sensors.	SI	M	SI	SI
14.	Duct type fire and smoke detectors, including relays for fan shut down.	E	E	E	SI
15.	Mechanical piping heat tracing (including relays, contactors, thermostats, etc.)	M	M	E	E
16.	Emergency power off (EPO) shut down pushbuttons (break glass station) and controls.	SI	SI	SI	SI
17.	Control interlock wiring or software bindings between boiler, pumps and fans and air handling units and other miscellaneous mechanical equipment.	SI	SI	SI	SI
18.	Electric radiant heating panels unducted electric unit heaters and cabinet heaters, and electric baseboard radiation.	E	E	E	E
19.	Airflow control devices with transmitter.	SI	M	SI	SI

**MARYLAND STATE POLICE TACTICAL SERVICES
OPERATIONS & COMMAND BUILDING**

Project No: PA-75-210-001

Item		Furnish By	Install By	Power By	Control Wiring By
21.	Intelligent Devices and Control Units provided with packaged mechanical equipment such as:	M		E	SI
	a. Valve & Damper operators				
	b. Heat Pumps, AC Units				
	c. Fan Coil Units				
	d. Air Terminal Units				
	e. Boiler				
22.	Intelligent Devices and Control Units provided with electrical systems such as:	E	E	E	SI
	a. Occupancy/Motion Sensors				
	b. Lighting Control Panels				
	c. Switches & Dimmers				
	d. Switch Multiplexing Control Units				
	e. Door Entry Control Units				
23.	Gateways or interfaces for protocol conversion with a non- based system.	M	E	E	SI
24.	Routers, Bridges and Repeaters.	SI	SI	SI	SI
<u>Abbreviations</u>					
Furnish.		Furnished by			
Install.		Installed by			
Power		Power Wiring Connection, Low and Medium Voltage			
SI		Systems Integrator			
M		Mechanical Contractor			
E		Electrical Contractor			

B. Notes to Schedule of Responsibilities:

- C. Magnetic motor starters (special duty type) shall be set in place under electrical division except when part of factory wired equipment, in which case set in place under mechanical division.
- D. Where a remote motor disconnect is required in addition to the one provided integral to and Variable Frequency Drive (VFD), the NI Contractor shall provide the necessary control interlock between the disconnects.
- E. The System Integrator shall inform the Mechanical Contractor and the Electrical Contractor of the additional capacity required of control power transformers.
 - 1. The Mechanical Contractor shall refer to the electrical specifications and plans for all power and control wiring and shall advise the Architect of any discrepancies prior to bidding. The System Integrator shall be responsible for all control wiring as outlined, whether called for by the mechanical or electrical drawings and specifications.

PART 6 SEQUENCE OF OPERATIONS

6.1 GENERAL:

- A. All sequences are performed by the DDC BMS Control System unless specifically noted otherwise. All sequences shall use PID control algorithms.
- B. All dampers shall be provided with end switches (end switches are not indicated on the drawings, but are required to be provided). Proof of damper operation via the associated end switch shall be established, otherwise an alarm condition shall be generated.
- C. All control valves shall be provided with end switches (end switches are not indicated on the drawings, but are required to be provided). Proof of valve operation via the associated end switch shall be established; otherwise, an alarm condition shall be generated.
- D. Scheduling. Provide the capability to schedule each object or group of objects in the system. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions (as applicable). Each schedule may consist of up to [10] events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:
 - 1. Weekly Schedule. Provide separate schedules for each day of the week. Occupied and unoccupied time schedules shall be programmed into the BMS time schedule subroutine. Time settings shall be verified in writing with the PGCPs project manager.
 - a. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall

- override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.
- b. **Holiday Schedules.** Provide the capability for the operator to define up to [99] special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
 - c. **Optimal Start/Stop.** The scheduling application outlined above shall support an optimal start/stop algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less than and greater than 24 hours. The start/stop algorithm shall be based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit (initially set at 60 minutes). Provide an early stop limit in minutes to prevent the system from stopping before an operator determined time limit (initially set at 30 minutes).
- E. All wall temperature sensors shall be provided with a unoccupied override button (which shall be labeled). When a unit is in the unoccupied mode and the button is momentarily depressed, the local system shall revert to the occupied mode operation for one hour. When in the occupied mode depressing the button shall cause no action.
- F. **Reverse Operation:** The sequences generally describe the action of the control system for one direction of change in the HVAC process of variables. The reverse sequence shall occur when the direction of change is reversed.
- G. **High/Low Space Temperature:** An alarm condition shall be initiated if the space temperature is either five degrees F (adjustable) above or five degrees F (adjustable) below any active space temperature set point (except for cooling set points during heating modes).
- H. **Sensor Fail:** A sensor failure alarm condition shall be initiated if the measurement of a sensor is outside a user adjustable defined normal operating range.

PART 7 EXECUTION

7.1 INSPECTION

- A. Examine areas and conditions under which direct digital control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

7.2 INSTALLATION OF DIRECT DIGITAL SYSTEMS

- A. General: Install systems and materials in accordance with manufacturer's instructions and roughing-in drawings, and details on drawings. Install electrical components and use electrical products complying with requirements of applicable Division 26 sections of these specifications. Check and verify location of exposed control sensors with plans and room details before installation.

7.3 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started. Provide a wall mounted temperature sensor (thermostat) for every controlled piece of HVAC equipment requiring such control, whether indicated on the plans or not.
- B. Coordinate the rough-in of control components in the field prior to installation to prevent conflicts with other wall mounted features such as white boards, tack boards, etc... All devices are to be indicated on the coordination shop drawings.
- C. The contractor shall inspect the site to verify that equipment is installable as shown, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

7.4 GENERAL WORKMANSHIP

- A. Install equipment, piping, wiring/conduit parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install all equipment in readily accessible location as defined by Chapter 1 Article 100 Part A of the NEC. Control panels shall be attached to structural walls unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

7.5 WIRING

- A. All control and interlock wiring shall comply with the national and local electrical codes and Division 26 of these specifications. Where the requirements of this section differ with those in Division 26, the requirements of this section shall take precedence.
- B. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:
 - 1. Circuits meet NEC Class 2 (current limited) requirements. (Low voltage power circuits shall be sub fused when required to meet Class 2 current limit.)
 - 2. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.
- C. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
- D. Where class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 3 m [10 ft] intervals. Such bundled cable shall be fastened to the structure, using specified fasteners, at 1.5 m [5 ft] intervals or more often to achieve a neat and workmanlike result.
- E. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- F. Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, the Control System Contractor shall provide step down transformers.
- G. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
- H. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with other sections of this specification and local codes.
- I. Size of conduit and size and type of wire shall be the design responsibility of the Control System Contractor, in keeping with the manufacturer's recommendation and NEC.
- J. Control and status relays are to be located in designated enclosures only. These relays may also be located within packaged equipment control panel enclosures. These relays shall not be located within Class 1 starter enclosures.

- K. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.
- L. Adhere to Division 26 requirements for installation of raceway.
- M. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as built) wiring diagrams with terminations identified at the job site.
- N. Flexible metal conduits and liquid tight, flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including boiler rooms, liquid tight and flexible metal conduits shall be used.

7.6 FIBER OPTIC CABLE SYSTEM

- A. All cabling shall be installed in a neat and workmanlike manner. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.
- B. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post installation residual cable tension shall be within cable manufacture's specifications.
- C. Fiber optic cabinets, hardware, and cable entering the cabinet shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.

7.7 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequate for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- D. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.
- E. Install duct static pressure tap with tube end facing directly down-stream of air flow.
- F. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.

- G. All pipe mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat conducting fluid in thermal wells.
- H. Wiring for space sensors shall be concealed in building walls. EMT conduit is acceptable within mechanical and service rooms.
- I. Install outdoor air temperature sensors on north wall complete with sun shield at designated location.

7.8 FLOW SWITCH INSTALLATION

- A. Install using a thread o let in steel pipe. In copper pipe use C x C x F Tee, no pipe extensions or substitutions allowed.
- B. Mount a minimum of 5 pipe diameters upstream and 5 pipe diameters downstream or 2 feet whichever is greater, from fittings and other obstructions.
- C. Install in accordance with manufacturers' instructions.
- D. Assure correct flow direction and alignment.
- E. Mount in horizontal piping flow switch on top of the pipe.

7.9 ACTUATORS

- A. Mount and link control damper actuators per manufacturer's instructions.
- B. To compress seals when spring return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
- C. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
- D. Valves - Actuators shall be mounted on valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following manufacturer's recommendations.

7.10 WARNING LABELS

- A. Affix plastic labels on each starter and equipment automatically controlled through the Control System. Label shall indicate the following:

C A U T I O N

This equipment is operating under automatic control and may start at any time without warning.

7.11 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory fabricated panels, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information.
- B. Permanently label or code each point of field terminal strips to show the instrument or item served.
- C. Identify control panels with minimum 1-cm letters on laminated plastic nameplates.
- D. Identify all other control components with permanent labels. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

7.12 CONTROLLERS

- A. Provide a separate Controller for each major piece of HVAC equipment. Points used for control loop reset such as outside air or space temperature are exempt from this requirement.
- B. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type found at each location. If input points are not universal, 15% of each type is required. If outputs are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used.
- C. Future use of spare capacity shall require providing the field device, field wiring, points database definition, and custom software. No additional Controller boards or point modules shall be required to implement use of these spare points.

7.13 PROGRAMMING

- A. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25% of available memory free for future use.
- B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.
- C. Software Programming

1. Provide programming for the system as per specifications and adhere to the strategy algorithms provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the Control System Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.

D. Operators' Interface

1. **Standard Graphics.** Provide graphics for each major piece of equipment and floor plan in the building. This includes each Air Handler, DOAS, VRV Unit, Cabinet Heater, Pumps and Boiler. These standard graphics shall show all points dynamically as specified in the points list.
2. The controls contractor shall provide all the labor necessary to install, initialize, start up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface data base, and any third-party software installation and integration required for successful operation of the operator interface.
3. As part of this execution phase, the controls contractor will perform a complete test of the operator interface. Test duration shall be a minimum of [16] hours on-site. Tests shall be made in the presence of the Owner or Owner's representative.

- E. Demonstration:** A complete demonstration and readout of the capabilities of the monitoring and control system shall be performed. The contractor shall dedicate a minimum of 16 hours on site with the Owner and his representatives for a complete functional demonstration of all the system requirements. This demonstration constitutes a joint acceptance inspection, and permits acceptance of the delivered system for on line operation.

7.14 CLEANING

- A.** This contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.
- B.** At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from dust, dirt and debris, etc.
- C.** At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

7.15 PROTECTION

- A. The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.
- B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

7.16 TRAINING

- A. Provide a minimum of 2 classroom training sessions, 4 hours each, throughout the contract period for personnel designated by the Owner. Computer based training may be substituted for up to 2 hours of hands-on training.
- B. Train the designated staff of Owner's representative and Owner to enable them to proficiently operate the system; create, modify and delete programming; add, remove and modify physical points for the system; add additional panels when required.
- C. These objectives will be divided into three logical groupings; participants may attend one or more of these, depending on level of knowledge required:
 - 1. Day-to-day Operators
 - 2. System Troubleshooter
 - 3. System Manager: parts
- D. Provide course outline and materials as per Part 1 of this Section. The instructor(s) shall provide one copy of training material per student.
- E. The instructor(s) shall be factory-trained instructors experienced in presenting this material.
- F. Classroom training shall be done using a network of working controllers' representative of the installed hardware or at the customer's site.

7.17 FIELD ADJUSTMENTS TO PROGRAMMING

- A. During Commissioning: The contractor shall include in his bid all costs associated to incorporate Engineer directed field adjustments to the programming, including the addition of new lines of code, changes to existing sequences, adjustment of set points, and other changes which do not involve providing additional material. Additional programming shall include up to an additional twenty-five percent of the number of lines of code. The commissioning period is defined as the period starting with the on-

site construction activities and ending upon the receipt of both the substantial completion certificate and the LEED Certification for the building,

- B. During the Warranty Period: The contractor shall include in his bid all cost associated to incorporate up to four groupings of modifications to the controls programming as directed by the Engineer after the completion of all commissioning activities. A grouping is defined as a set of changes to programming indicated in the contract documents or additional programming issued in writing by the engineer under the title of "Program Modification Group #1, 2, 3 or 4". Adjustments or corrections to programming to obtain compliance with the contract documents are not work of these program modifications.

7.18 FIELD QUALITY CONTROL

- A. All work, materials and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this Section.
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to building lines and properly supported.
- C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

7.19 ACCEPTANCE

- A. The control systems will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of both the Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Owner's representative. Such tests shall then be performed as part of the warranty.

END OF SECTION

SECTION 232300 - REFRIGERANT PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes refrigerant piping used for air conditioning applications. This Section includes:
 - 1. Pipes, tubing, fittings, and specialties.
 - 2. Refrigerants
- B. Related Sections: Division 230050 Section "Basic Mechanical Materials and Methods" for sealing pipe penetrations through basement walls and fire/smoke barriers.
- C. Products installed but not furnished under this Section include pre-charged tubing, refrigerant specialties, and refrigerant accessories furnished as an integral part of or separately with packaged air conditioning equipment.

1.2 SUBMITTALS

- A. Product data for the following products:
 - 1. Each type valve specified.
 - 2. Each type refrigerant piping specialty specified.
- B. Brazer's Certificates signed by Contractor certifying that brazers comply with requirements specified under "Quality Control" below.
- C. Maintenance data for refrigerant valves and piping specialties, for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 230010 Section "Basic Mechanical Requirements."

1.3 QUALITY CONTROL

- A. Qualify brazing processes and brazing operators in accordance with ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications."
- B. Regulatory Requirements: Comply with provisions of the following codes:
 - 1. ANSI B31.5: ASME Code for Pressure Piping - Refrigerant Piping.
 - 2. ANSI/ASHRAE Standard 23: Safety Code for Mechanical Refrigeration.
 - 3. International Mechanical Code.

1.4 SEQUENCING AND SCHEDULING

- A. Coordinate the installation of roof piping supports, and roof penetrations.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Refrigerant Valves and Specialties:
 - 1. Alco Controls Div. Emerson Electric.
 - 2. Danfoss Electronics, Inc.
 - 3. EATON Corporation, Control Div.
 - 4. Henry Valve Company.
 - 5. Parker-Hannifin Corporation, Refrigeration and Air Conditioning Division.
 - 6. Sporlan Valve Company.

2.2 PIPE AND TUBING MATERIALS

- A. General: Refer to Part 3, Article "PIPE APPLICATION" for identification of systems where the below specified pipe and fitting materials are used.
- B. Copper Tubing: ASTM B 280, Type ACR, hard-drawn straight lengths, and soft-annealed coils, seamless copper tubing. Tubing shall be factory cleaned, ready for installation, and have ends capped to protect cleanliness of pipe interiors prior to shipping.
- C. Copper Tubing: ASTM B 88, Type L, hard-drawn straight lengths, and soft-annealed coils, seamless copper tubing.

2.3 FITTINGS

- A. Wrought-Copper Fittings: ANSI B16.22, streamlined pattern.

2.4 JOINING MATERIALS

- A. Brazing Filler Materials: AWS A5.8, Classification BAg-1 (Silver).

2.5 VALVES

- A. General: Complete valve assembly shall be UL-listed and designed to conform to ARI 760.
- B. Globe: 450 psig maximum operating pressure, 275 deg. F maximum operating temperature; cast bronze body, with cast bronze or forged brass wing cap and bolted bonnet; replaceable resilient seat disc; plated steel stem. Valve shall be capable of being repacked under pressure. Valve shall be straight through or angle pattern, with solder-end connections.
- C. Check Valves - 7/8 inch and Larger: 450 psig maximum operating pressure, 300 deg. F maximum operating temperature; cast bronze body, with cast bronze or forged brass bolted bonnet; floating piston with mechanically retained Teflon seat disc. Valve shall be straight through or angle pattern, with solder-end connections.
- D. Solenoid Valves: 250 deg. F temperature rating, 400 psig working pressure; forged brass, with Teflon valve seat, two-way straight through pattern, and solder end connections. Provide manual operator to open valve. Furnish complete with NEMA 1 solenoid enclosure with 1/2-inch conduit adapter, and 24-volt, 60 Hz. normally closed holding coil.
- E. Thermal Expansion Valves: Thermostatic adjustable, modulating type; size as required for specific evaporator requirements, and factory set for proper evaporator superheat requirements. Valves shall have copper fittings for solder end connections; complete with sensing bulb, a distributor having a side connection for hot gas bypass line, and an external equalizer line.

2.6 REFRIGERANT PIPING SPECIALTIES

- A. General: Complete refrigerant piping specialty assembly shall be UL-listed and designed to conform to ARI 760.
- B. Strainers: 500 psig maximum working pressure; forged brass body with monel 80-mesh screen, and screwed cleanout plug; Y-pattern, with solder end connections.
- C. Moisture/liquid Indicators: 500 psig maximum operation pressure, 200 deg. F maximum operating temperature; forged brass body, with replaceable polished optical viewing window, and solder end connections.
- D. Filter-driers: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel capscrews, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter-drier core kit, including Standard capacity desiccant sieves to provide micronic filtration.
- E. Suction Line Filter-Drier: 350 psig maximum operation pressure, 225 deg. F maximum operating temperature; steel shell, and wrought copper fittings for solder end connections. Permanent filter element shall be molded felt core surrounded by a desiccant for removal

of acids and moisture from refrigerant vapor.

- F. Flanged Unions: 400 psig maximum working pressure, 330 deg. F maximum operating temperature; two brass tailpiece adapters for solder end connections to copper tubing; flanges for 7/8 inch through 1-5/8-inch unions shall be forged steel, and for 2-1/8 inch through 3-1/8 inch shall be ductile iron; four plated steel bolts, with silicon bronze nuts and fiber gasket. Flanges and bolts shall have factory-applied rust-resistant coating.
- G. Flexible Connectors: 500 psig maximum operating pressure; seamless tin bronze or stainless-steel core, high tensile bronze braid covering, solder connections, and synthetic covering; dehydrated, pressure tested, minimum 7 inch in length.

2.7 REFRIGERANT

- A. Refrigerant No.410A, in accordance with ASHRAE Standard 34.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine rough-in for refrigerant piping systems to verify actual locations of piping connections prior to installation.

3.2 PIPE APPLICATIONS

- A. Use Type L, or Type ACR drawn copper tubing with wrought copper fittings and brazed joints above ground, within building. Use Type K, annealed temper copper tubing for 2 inch and smaller without joints, below ground and within slabs. Mechanical fittings (crimp or flare) are not permitted.
- B. Install annealed temper tubing in pipe duct. Vent pipe duct to the outside.
- C. If other than Type ACR tubing is used, clean and protect inside of tubing as specified in Article "CLEANING" below.
- D. Small systems 1/8 inch through 7/8 inch outside diameter may use pre-charged refrigerant tubing sets with mechanical (flare) fittings.

3.3 PIPING INSTALLATIONS

- A. General: Install refrigerant piping in accordance with ASHRAE Standard 15 - "The Safety Code for Mechanical Refrigeration."

- B. Install piping in as short and direct arrangement as possible to minimize pressure drop.
- C. Install piping for minimum number of joints using as few elbows and other fitting as possible.
- D. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.
- E. Provide adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.
- F. Insulate suction lines. Liquid lines are not required to be insulated, except where they are installed adjacent and clamped to suction lines, where both liquid and suction lines shall be insulated as a unit.
- G. Do not install insulation until system testing has been completed and all leaks have been eliminated.
- H. Install branch tie-in lines to parallel compressors equal length, and pipe identically and symmetrically.
- I. Slope refrigerant piping as follows:
 - 1. Install horizontal hot gas discharge piping with 1/2 inch per 10 feet downward slope away from the compressor.
 - 2. Install horizontal suction lines with 1/2 inch per 10 feet downward slope to the compressor, with no long traps or dead ends which may cause oil to separate from the suction gas and return to the compressor in damaging slugs.
 - 3. Install traps and double risers where indicated, and where required to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- J. Use fittings for all changes in direction and all branch connections.
- K. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- L. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- M. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

- N. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- O. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6 inches shall be steel; pipe sleeves 6 inch and larger shall be sheet metal.
- P. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Division 7 for special sealers and materials.
- Q. Install moisture/liquid indicators in liquid lines between filter/driers and thermostatic expansion valves and in liquid line to receiver.
- R. Install moisture/liquid indicators in lines larger than 2-1/8-inch OD, using a bypass line.
- S. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to compressors and evaporators.
- T. Install flexible connectors at the inlet and discharge connection of compressors.

3.4 HANGERS AND SUPPORTS.

- A. General: Hanger supports and anchors are specified in Division 230529 Section "Supports and Anchors". Conform to the table below for maximum spacing of supports.
- B. Install the following pipe attachments.
- C. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet in length.
- D. Spring hangers to support vertical runs.
- E. Install hangers with the following minimum rod sizes and maximum spacing:

<u>NOM. PIPE SIZE-INCH</u>	<u>MAX. SPAN-FT</u>	<u>MIN. ROD SIZE - INCH</u>
1	7	3/8
1-1/2	9	3/8
2	10	3/8
3	12	1/2
3-1/2	13	1/2
4	14	5/8
5	16	5/8
6	17	3/4
8	19	7/8

- F. Support vertical runs at each floor.

3.5 PIPE JOINT CONSTRUCTION

- A. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
 - 1. **WARNING:** Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
 - 2. **CAUTION:** When solenoid valves are being installed, remove the coil to prevent damage. When sight glasses are being installed, remove the glass. Remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties before brazing. Do not apply heat near the bulb of the expansion valve.
- B. Fill the pipe and fittings during brazing, with an inert gas (i.e., nitrogen or carbon dioxide) to prevent formation of scale.
- C. Heat joints using oxy-acetylene torch. Heat to proper and uniform brazing temperature.

3.6 VALVE INSTALLATIONS

- A. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions.
- B. Install globe valves on each side of strainers and driers, in liquid and suction lines at evaporators, and elsewhere as indicated.
- C. Install a full sized, 3-valve bypass around each drier.
- D. Install solenoid valves ahead of each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at the top.
- E. Electrical wiring for solenoid valves is specified in Division 26. Coordinate electrical requirements and connections.
- F. Thermostatic expansion valves may be mounted in any position, as close as possible to the evaporator.
- G. Where refrigerant distributors are used, mount the distributor directly on the expansion valve outlet.
- H. Install the valve in such a location so that the diaphragm case is warmer than the bulb.
- I. Secure the bulb to a clean, straight, horizontal section of the suction line using two bulb straps. Do not mount bulb in a trap or at the bottom of the line.

- J. Where external equalizer lines are required make the connection where it will clearly reflect the pressure existing in the suction line at the bulb location.
- K. Install pressure regulating and relieving valves as required by ASHRAE Standard 15.

3.7 EQUIPMENT CONNECTIONS

- A. The Drawings indicate the general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow servicing and maintenance.

3.8 FIELD QUALITY CONTROL

- A. Inspect, test, and perform corrective action of refrigerant piping in accordance with ASME Code B31.5, Chapter VI.
- B. Repair leaking joints using new materials, and retest for leaks.

3.9 CLEANING

- A. Before installation of copper tubing other than Type ACR tubing, clean the tubing and fitting using following cleaning procedure:
 - 1. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through the tubing by means of a wire or an electrician's tape.
 - 2. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
 - 3. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
 - 4. Finally, draw a clean, dry, lintless cloth through the tube or pipe.

3.10 ADJUSTING AND CLEANING

- A. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.
- B. Clean and inspect refrigerant piping systems for completion of joints, supports and accessory items.
- C. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

3.11 COMMISSIONING

- A. Charge system using the following procedure:
 - 1. Install core in filter dryer after leak test but before evacuation.
 - 2. Evacuate refrigerant system with vacuum pump; until temperature of 35 deg F is indicated on vacuum dehydration indicator.
 - 3. During excavation, apply heat to pockets, elbows, and low spots in piping.
 - 4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
 - 5. Break vacuum with refrigerant gas, allow pressure to build up to 2 psi.
 - 6. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.

- B. Train Department's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing, and preventative maintenance of refrigerant piping valves and refrigerant piping specialties.

- C. Review data in Operating and Maintenance Manuals. Refer to Division 1 section "Project Closeout."

- D. Schedule training with owner through the Professional, with at least 7 days advance notice.

END OF SECTION

SECTION 233113 - METAL DUCTWORK

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 23 Sections apply to this section:
 - 1. "Basic Mechanical Requirements."
 - 2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY

- A. This Section includes the construction and testing of rectangular, round, and flat-oval metal ducts and plenums for heating, ventilating, and air conditioning systems in pressure classes from minus 2 inch to plus 10-inch water gauge.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 230050 Section "Basic Mechanical Materials and Methods" for joint sealers for fire-resistant sealants for use around duct penetrations and fire damper installations in fire rated floors, partitions, and walls.
 - 2. Division 235250 Section "Mechanical Insulation" for exterior duct and plenum insulation.

1.3 DEFINITIONS

- A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:
- B. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
- C. Joints: Joints include girth joints; branch and sub branch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:
 - 1. Duct Liner.
 - 2. Sealing Materials.
 - 3. Fire-Stopping Materials.
- C. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4-inch equals 1 foot, on drawing sheets same size as the Contract Drawings.
- D. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
- E. Duct layout, indicating pressure classifications and sizes in the plan view. For exhaust ducts systems, indicate the classification of the materials handled as defined in this Section.
 - 1. Fittings.
 - 2. Reinforcing details and spacing.
 - 3. Seam and joint construction details.
 - 4. Penetrations through fire-rated and other partitions.
 - 5. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
- F. Welding certificates including welding procedures specifications, welding procedures qualifications test records, and welders' qualifications test records complying with requirements specified in "Quality Control" below.
- G. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 23 Section "Basic Mechanical Requirements" and Division 1.

1.5 QUALITY CONTROL

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."
- B. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.
- C. NFPA Compliance: Comply with the following NFPA Standards:

1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems", except as indicated otherwise.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sealant and fire-stopping materials to site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle sealant fire-stopping materials in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.
- C. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

PART 2 PRODUCTS

2.1 SHEET METAL MATERIALS

- A. Sheet Metal, General: Provide sheet metal in thicknesses indicated, packaged and marked as specified in ASTM A 700.
- B. Galvanized Sheet Steel: Lock-forming quality, ASTM A 527, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.
- C. Carbon Steel Sheets: ASTM A 366, cold-rolled sheets, commercial quality, with oiled, exposed matte finish.
- D. Stainless Steel: ASTM A 480, Type 316, sheet form, with No. 4 finish on exposed surface for ducts exposed to view; Type 304, sheet form, with No.1 finish for concealed ducts.
- E. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless-steel ducts provide reinforcing of compatible materials.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 SEALING MATERIALS

- A. Joint and Seam Sealants, General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.
- B. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with the tape to form a hard, durable, airtight seal.
- C. Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 75 percent solids.
- D. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

2.3 FIRE-STOPPING

- A. Refer to Division 230050 Section "Basic Mechanical Materials and Methods" for fire-stopping.

2.4 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4 inches thick.
- B. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.
 - 1. Hangers Installed in Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.
 - 2. Straps and Rod Sizes: Conform with Table 4-1 in SMACNA HVAC Duct Construction Standards, 1985 Edition, for sheet steel width and gauge and steel rod diameters.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.
 - 1. Where galvanized steel ducts are installed, provide hot-dipped- galvanized steel shapes and plates.
 - 2. For stainless steel ducts, provide stainless steel support materials.
 - 3. For aluminum ducts, provide aluminum support materials, except where materials are electrolytically separated from ductwork.

2.5 RECTANGULAR DUCT FABRICATION

- A. General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards", Tables 1-3 through 1-19, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.
 - 1. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
 - 2. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
- B. Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications:
 - 1. Supply Ducts: 2-inch water gauge.
 - 2. Return Ducts: 2-inch water gauge, negative pressure.
 - 3. Exhaust Ducts: 1 inch water gauge, negative pressure.
- C. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inch and larger and are 20 gauge or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standard", Figure 1-4, unless they are lined or are externally insulated.

2.6 RECTANGULAR DUCT FITTINGS

- A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard", 1985 Edition, Figures 2-1 through 2-10.

2.7 ROUND DUCT FABRICATION

- A. General: Fabricate round supply ducts with spiral lockseam construction. Comply with SMACNA "HVAC Duct Construction Standards", Table 3-2 for galvanized steel gauges.

2.8 ROUND SUPPLY AND EXHAUST FITTINGS FABRICATION

- A. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards", 1985 Edition, Figures 3-4 and 3-5 and with metal thicknesses specified for longitudinal seam straight duct.
- B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.

- C. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter. Unless elbow construction type is indicated, provide elbows meeting the following requirements:
 - 1. Round Elbows - 8 Inch and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle
 - 2. Configurations or 1/2-inch-diameter (e.g., 3-1/2- and 4-1/2-inch) elbows with gored construction.

- D. Round Elbows - 9 Through 14 Inch: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.

PART 3 EXECUTION

3.1 DUCT COORDINATION, FABRICATION AND INSTALLATION, GENERAL

- A. Coordination drawings are required in addition ductwork shop drawings; see Section “Basic Mechanical Requirements”. No ductwork shall be fabricated prior to the contractor obtaining approved coordination shop drawings signed by the engineer. The contractor shall remove and replace any ductwork fabricated without said approved coordination shop drawings and provide ductwork per the approved coordination shop drawings at no additional cost.

- B. Install ducts with the fewest possible joints. The drawings indicate the general intent of the duct layout system along with the types and styles of take-offs and fittings. Adjustments are to be provided in the field to coordinate the ductwork with the actual field clearances. Provide all labor, supervision, equipment, transportation, and all other costs to execute field coordination. Adjust the position of ductwork and the aspect ratio (size) while maintaining the equivalent diameter, to resolve any and all spatial conflicts. Material costs for adjustments in the aspect ratio and routing of the ductwork for coordination shall be include as part of the base bid.

- C. The contractor shall review all portions of the contract documents, including all drawings of all disciplines in performing his bid and coordination activities. The contractor shall provide dynamic fire dampers of the appropriate rating at all ductwork penetrations of assemblies indicated on the architectural drawings as fire rated; whether the fire dampers are indicated on the mechanical plans or not. The contractor shall provide smoke dampers at ductwork penetrations of assemblies indicated on the architectural drawings as smoke rated; whether the smoke dampers are indicated on the mechanical plans or not. Combination fire/smoke dampers of appropriate classification shall be provided when the assembly is both fire and smoke rated. All smoke rated dampers shall be provided with required actuation and control.

- D. Duct System Pressure Class: Construct and install each duct system for the specific duct pressure classification indicated.
- E. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.
- F. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.
- G. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.
- H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.
- J. Install insulated ducts with 1-inch clearance outside of insulation.
- K. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.
- L. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- M. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- N. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1 1/2 inch.
- O. Paint interior of ductwork behind all duct mounted air inlets and outlets; except for sound lined ducts.

3.2 SEAM AND JOINT SEALING

- A. General: Seal all duct seams and joints (transverse and longitudinal – SMACNA SEAL CLASS A) regardless of pressure class. Seal externally insulated ducts prior to insulation installation.

3.3 HANGING AND SUPPORTING

- A. Install rigid round and rectangular duct with support systems indicated in SMACNA "HVAC Duct Construction Standards", Tables 4-1 through 4-3 and Figures 4-1 through 4-8.
- B. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.
- C. Support vertical ducts at a maximum interval of 16 feet and at each floor.
- D. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated.
- E. Install concrete insert prior to placing concrete.
- F. Install power actuated concrete fasteners after concrete is placed and completely cured.

3.4 CONNECTIONS

- A. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 23 Section "Duct Accessories."
- B. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards", Figures 2-7 and 2-8.
- C. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards", Figures 2-16 through 2-18.

3.5 QUALITY CONTROL

- A. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

3.6 FIELD QUALITY CONTROL

- A. Perform air duct leakage testing of all ductwork in accordance with the SMANCA HVAC Air Duct Leakage Test Manual – 1985. Disassemble, reassemble, and seal segments of the systems as required to accommodate leakage testing, and as required for compliance with test requirements.
- B. Conduct tests, in the presence of the commissioning agent and owner's representative, at static pressures equal to the maximum design pressure of the system or the section being tested. If pressure classifications are not indicated, test entire system at the maximum system design pressure. Do not pressurize system above the maximum

design operating pressure. Provide 7 days advanced notice for testing. Provide a report of findings indicating the ductwork section, test pressures, measured values, and results. Indicate remedial actions taken and follow-up results.

- C. Determine leakage from entire system or section of the system by relating leakage to the surface area of the test section.
- D. Maximum Allowable Leakage: As described in ASHRAE 2005 Handbook, "Fundamentals" Volume, Chapter 35, Table 6 and Figure 10. Comply with requirements for leakage classification 3 for all ductwork regardless of function or pressure class.
- E. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

END OF SECTION

SECTION 23 33 20 ACOUSTIC ROOF CURB

PART 1 GENERAL

1.1 RELATED SECTIONS

- A. Section 013000 - Administrative Requirements.
- B. Section 014000 - Quality Requirements
- C. Section 017419 - Construction Waste Management and Disposal
- D. Section 017800 - Closeout Submittals.
- E. Section 017900 - Demonstration and Training
- F. Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- G. Section 233100 - HVAC Ducts and Casings: Connections to silencers.
- H. Section 233300 - Air Duct Accessories: Flexible duct connections.

1.2 REFERENCE STANDARDS:

AMCA 511 – Certified Ratings Program Product Rating Manual for Air Control Devices
ASHRAE Applications Handbook, Chapter 48 “Noise and Vibration Control”; 2015
ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated
(Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-dip Process; 2015
ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building
Materials; 2016
ASTM E90 – Standard Test Method for Laboratory Measurement of Airborne Sound
Transmission Loss of Building Partitions and Elements; 2009
ASTM C423 – Standard Test Method for Sound Absorption and Sound Absorption
Coefficients by the Reverberation Room Method; 2009
NFPA 90A – Std for the Installation of Air-Conditioning and Ventilating Systems; 2015
NFPA 90B – Standard for the Installation of Warm Air Heating and Air-Conditioning
Systems; 2015
NFPA 255 – Standard Method of Test of Surface Burning Characteristics of Building
Materials; 2006
SMACNA 006-2006 – HVAC Duct Construction Standards – Metal and Flexible; 2006

UL 723 – Std for Test for Surface Burning Characteristics of Building Materials; 2008

1.3 SUBMITTALS

- A. See SECTION 013000 – Administrative Requirements for submittal procedures.
- B. Product Data
- C. Noise reductive roof curb manufacturer to provide submittal drawings detailing all acoustic curb data specified in the mechanical drawing or schedule.
- D. Noise reductive roof curb manufacturer shall submit certified laboratory performance obtained in accordance with ASTM E90 and ASTM C423.
- E. Data for each acoustic roof curb shall be provided with the dimensions, configuration, construction materials, material finishes, assembly instructions and installation details.

1.4 QUALITY CONTROL

- A. Acoustic panel manufacturer must have a minimum ten (10) years of industry experience.

1.5 WARRANTY

- A. Provide 12-month manufacturer warranty from date of shipment for acoustic roof curbs.
- B. See Section 017800 – Closeout SUBMITTALS, for additional warranty requirements.

PART 2 PRODUCTS

2.1 NOISE REDUCTIVE ROOF CURBS

- A. Basis of Design: Price Industries
- B. Micrometl
- C. Thybar

2.2 ALTERNATE MANUFACTURERS:

- A. Alternate manufacturers must obtain written approval by the project engineer to bid.

- B. As a condition of pre-approval, alternate manufacturers must submit to the project engineer, HVAC acoustic floor barrier panel test reports for an acoustic floor barrier panel tested in accordance with ASTM E90 in a test facility that is NVLAP-accredited for ASTM E90.

2.3 GENERAL:

- A. General contractor to provide all labor, materials and equipment for the complete installation of the acoustic roof curb.

2.4 PERFORMANCE:

- A. Acoustic floor barrier panels equivalent to Price AP4 model shall meet or exceed the acoustic performance in the table below.
- B. DOAS-1:
- C. Transmission Loss (TL) Values, dB:

Freq.	63	125	250	500	1K	2K	4K	STC
Transmission Loss	17	27	40	54	61	64	61	52

- D. Acoustic floor barrier panels equivalent to Price AP6 model shall meet 30 dBA in the space Directly below the Units. Alternate manufacturers to provide detailed acoustical Analysis meeting or exceeding performance: DOAS-1
- E. Construction:
 - 1. Prefabricated structural acoustic roof curbs as schedules:
 - a. Coated steel sheet curb sections, corners fully mitered and welded; 1” x 4” pressure treated continuous wood nailers fastened at 12” on center to exterior of curb.
 - b. Insulated with 2” x 1.5# density duct liner.
 - 2. Profile height: Comply with local code requirements for minimum curb height, but in no case shall curb height be less than 24” as measured from top of roof membrane to top of curb.
 - 3. Sheet metal gauge: To be determined by unit weight.
 - 4. Isolation rail:
 - a. Spring components shall be 2” deflection, free-standing, unhooded, laterally stable steel springs. Springs shall have a lateral stiffness greater than 1.0 times the rated vertical stiffness and shall be designed for 50% overload to solid.

- b. Springs shall be color coded to indicate load capacity.
 - c. Rails shall provide continuous support for the rooftop equipment and shall be designed to provide isolation against casing-radiated vibration in the rooftop equipment housing and structure borne vibration from rotating and mechanical equipment in the rooftop package.
 - d. Rail assembly shall consist of extruded aluminum top and bottom members connected by spring isolators and a continuous air- and water-tight seal. The seal shall be a beaded elastomeric material retained in a keyway along the top extrusion. The weather strip shall be sealed along the bottom with an aluminum fascia strip.
 - e. Rail assemblies shall incorporate means for attachment to the building and the supported equipment and shall incorporate additional stiffening members if necessary to assure stability.
 - f. Vibration isolator shall be selected by the manufacturer for each specific application to comply with deflection requirements as shown on the Vibration Isolation Schedule or as indicated on the project documents.
5. Acoustic barrier panels Price AP4 model for (DOAS-1)
- a. Acoustic barrier panels shall be tongue and groove construction, four-inch depth, and shall consist of:
 - 1) 18-gauge solid steel skin
 - 2) 22-gauge solid steel liner
 - 3) 18-gauge full depth splitters spaced a maximum of 16 inches apart
 - 4) Absorptive acoustic fiberglass media
6. Acoustic media:
- a. Acoustic media shall be fiberglass insulation with imbedded 5/8" gypsum board type X.
 - b. Media shall be packed with a minimum of 10% compression to eliminate voids and settling.
7. Fire-Performance Characteristics:
- a. Acoustic barrier panel assemblies, including acoustic media fill, sealants, and acoustical spacers shall have combustion rating equal to or less than shown below when tested according to ASTM E84, NFPA 255 or UL 723:
 - 1) Flame-spread index not exceeding 25
 - 2) Smoke-developed index not exceeding 50
8. Acoustic barrier panels Price AP6 model for (DOAS-1). Acoustic barrier panels shall be tongue and groove construction, six-inch depth, and shall consist of:
- a. 18-gauge solid steel skin
 - b. 22 gauge Perforated steel liner
 - c. 22 gauge and 16-gauge solid steel septum
 - d. 18-gauge full depth splitters spaced a maximum of 16 inches apart
 - e. Absorptive acoustic fiberglass media

9. Acoustic media:
 - a. 4" Bottom Panel Acoustic media shall be fiberglass insulation with imbedded 5/8" gypsum board type X.
 - b. 2" Top Panel Acoustic media shall be fiberglass insulation
 - c. Media shall be packed with a minimum of 10% compression to eliminate voids and settling.

10. Fire-Performance Characteristics:
 - a. Acoustic barrier panel assemblies, including acoustic media fill, sealants, and acoustical spacers shall have combustion rating equal to or less than shown below when tested according to ASTM E84, NFPA 255 or UL 723:
 - 1) Flame-spread index not exceeding 25
 - 2) Smoke-developed index not exceeding 50

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install acoustic roof curb in accordance with manufacturer's recommendations and as shown on the construction documents or Submittal Drawings.

3.2 FIELD QUALITY CONTROL

- A. See SECTION 014000 - QUALITY REQUIREMENTS for additional requirements.

3.3 CLEANING

- A. See SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

3.4 CLOSEOUT ACTIVITIES

- A. See SECTION 017800 - CLOSEOUT SUBMITTALS for closeout submittals.
- B. See SECTION 017900 - DEMONSTRATION AND TRAINING for additional requirements.

END OF SECTION

SECTION 233300 - DUCTWORK ACCESSORIES

PART 1 GENERAL

1.1 SUBMITTALS

- A. Submittals Package: Submit product data and quality control submittals specified below at the same time as a package.
- B. Product Data: Manufacturer's catalog sheets, specifications, and installation instructions for each item specified.
- C. For piping, including manufacturer's name, schedule, type or class of pipe and fittings, method of joining pipe and fittings. Pressure test results, for approval by the engineer.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 23 Sections apply to this section:
 - 1. "Basic Mechanical Requirements."
 - 2. "Basic Mechanical Materials and Methods."

1.3 SUMMARY

- A. Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this section. The work of this section may be found on drawings, in these specifications, on one but not the other, or on both; the contractor must use these specifications in conjunction with the drawings to determine the contract requirements.
- B. Types of ductwork accessories required for project include the following:
 - 1. Dampers.
 - a. Low pressure manual dampers.
 - b. Counterbalanced relief dampers.
 - 2. Fire dampers.
 - 3. Smoke dampers
 - 4. Fire and Smoke combination damper
 - 5. Turning vanes.
 - 6. Duct hardware.
 - 7. Duct access doors.

8. Flexible Duct connections.
9. Flexible Ducts

C. Related Sections: Other Division 23 sections for control dampers, testing, adjusting, and balancing of ductwork accessories; not work of this section.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction; and installation instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.
- C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.5 QUALITY CONTROL

- A. Codes and Standards
 1. SMACNA Compliance: Comply with applicable portions of SMACNA "HVAC Duct Construction Standards, Metal and Flexible" in regard to the construction of required work. No provision in the standard shall be interpreted as limiting any other requirement listed in the contract.
 2. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.
 3. UL Compliance: Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers."
 4. UL Compliance: Construct, test and label smoke dampers and combination smoke and fire dampers in accordance with UL Standard 555S "Leakage Rated Dampers for Use in Smoke Control Systems."
 5. NFPA Compliance: Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.

PART 2 PRODUCTS

2.1 DAMPERS

- A. Low Pressure Manual Dampers: Provide dampers of single blade type or multi-blade type, constructed in accordance with SMACNA "HVAC Duct Construction Standards."

- B. Counterbalanced Relief Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to relieve at indicated static pressure. Construct blades of 16-ga aluminum, provide 1/2-inch diameter ball bearings, 1/2-inch diameter steel axles spaced on 9-inch centers. Construct frame of 2 x 1/2 x 1/8-inch steel channel for face areas 25 sq. ft. and under; 4 x 1-1/4 inch x 16-ga channel for face areas over 25 sq. ft. Provide galvanized steel finish on frame with aluminum touch-up.
- C. Manufacturers: Subject to compliance with requirements, provide dampers of one of the following:
 - 1. Air Balance, Inc.
 - 2. Airguide Corp.
 - 3. American Warming & Ventilating, Inc.
 - 4. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
 - 5. Louvers & Dampers, Inc.
 - 6. Penn Ventilator Co.
 - 7. Ruskin Mfg. Co.

2.2 FIRE AND SMOKE DAMPERS

- A. Fire Dampers: Provide fire dampers with the following features:
 - 1. For galvanized steel ductwork all components of fire dampers shall be galvanized. All fire dampers located in stainless steel ductwork shall be matching 304 and 316 stainless steels including all components, unless otherwise indicated.
 - 2. Free area of fire damper must be equal to the full area of the duct in which it is installed, except when the damper is installed immediately behind an air inlet or outlet.
 - 3. Dampers to be constructed of mill finish galvanized steel per ASTM Standards A525 G60 of the following gauges: frame-20, curtain-24, and enclosure-20.
 - 4. Fire damper to be interlocking curtain type with UL 555 listed, 165 degrees F fusible link. Dynamic rated. Gravity operated for vertical installation; spring closure with latches for horizontal installation.
- B. Smoke Dampers: Provide smoke dampers with the following features:
 - 1. Rating: All dampers shall have operators installed at time of damper fabrication, shall be supplied as a single entity, bear a UL label attesting that the damper has been classified as a Class II leakage rated damper under UL555S and conform to NFPA 90A requirements. The dampers and their operators shall be qualified under UL555S to an elevated temperature of 250-, 350- or 450-degrees F depending on the operator.
 - 2. Low Pressure Air Systems: Up to 4-inch water gauge:
 - a. Frame shall be a minimum of 16-gauge galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement. The blades shall be single skin 16 gauge minimum galvanized with three

- longitudinal grooves for reinforcement. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Blade edge seals shall be silicone rubber designed to withstand 450 degrees F and jamb seal shall be stainless steel flexible metal compression type.
- b. Dampers shall have the capacity to open and close with pressures of at least 4-inch water gauge in the closed position and 2000 fpm air velocity.
 - c. Damper actuators shall use 24 VAC power, normally closed.
3. Low Pressure Air Systems: Up to 4-inch water gauge: Small size dampers:
- a. Frame shall be a minimum of 20-gauge galvanized steel and blade shall be two-piece equivalent to 20 gauge minimum galvanized. Bearing shall be stainless steel sleeve turning in an extruded hole in the frame. Blade edge seal shall be silicone rubber designed to withstand 450 degrees F and fully encompassing blade edge.
 - b. Dampers shall have the capacity to open and close with pressures of at least 4-inch water gauge in the closed position and 2000 fpm air velocity.
 - c. Damper actuators shall use 24 VAC power, normally closed.
- C. Combination Smoke and Fire Dampers: Provide combination smoke and fire dampers with the following features:
1. Rating: All dampers shall have operators installed at time of damper fabrication, shall be supplied as a single entity, bear a UL label attesting that the damper has been classified as a Class II leakage rated damper under UL555S and conform to NFPA 90A requirements. The dampers and their operators shall be qualified under UL555S to an elevated temperature of 250-, 350-, or 450-degrees F depending upon the operator. Each combination damper shall be 1-1/2 hour fire rated under UL555. Manufacturer shall provide factory assembled sleeve of 16-inch minimum length (verify requirement). Sleeve shall be 20 gauge for dampers through 36 x 48 inch and 18 gauge above 36 x 48 inch.
 2. Low Pressure Air Systems: Up to 4-inch water gauge:
 - a. Frame shall be a minimum of 16-gauge galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement. The blades shall be single skin 16 gauge minimum galvanized with three longitudinal grooves for reinforcement. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Blade edge seals shall be silicone rubber designed to withstand 450 degrees F and jamb seal shall be stainless steel flexible metal compression type.
 - b. Dampers shall have the capacity to open and close with pressure of at least 4-inch water gauge in the closed position and 2000 fpm air velocity.
- D. Manufacturers: Subject to compliance with requirements, provide fire and smoke dampers of one of the following:
1. Advanced Air, Division of Allied Thermal Corporation:
 2. Air Balance, Inc.

3. Louvers and Dampers, Inc.
4. Metalaire
5. Ruskin Mfg. Co.

2.3 TURNING VANES

- A. Fabricated Turning Vanes: Provide fabricated turning vanes and vane runners, constructed in accordance with SMACNA "HVAC Duct Construction Standards."
- B. Manufactured Turning Vanes: Provide turning vanes constructed of 1-1/2-inch-wide curved blades set at 3/4-inch o.c. supported with bars perpendicular to blades set at 2-inch o.c. and set into side strips suitable for mounting in ductwork.
- C. Manufacturers: Subject to compliance with requirements, provide turning vanes of one of the following:
 1. Aero Dyne Co.
 2. Airsan Corp.
 3. Anemostat Products Div.; Dynamics Corp. of America.
 4. Duro Dyne Corp.
 5. Environmental Elements Corp.; Subs. Koppers Co., Inc.
 6. Hart & Cooley Mfg. Co.

2.4 DUCT HARDWARE

- A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:
 1. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests. Cover shall seal air tight.
 2. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12 inches. Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

2.5 DUCT ACCESS DOORS

- A. General: Provide duct access doors of size to permit maintenance but not less than 15 x 15 inch where duct permits and 18 x 2 inch smaller than duct width.
- B. Construction: Construct of same or greater gauge as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with one

handle-type latch for doors 12 inch high and smaller, 2 handle-type latches for larger doors. Gasket all edges with closed cell neoprene to prevent air leakage.

- C. Manufacturers: Subject to compliance with requirements, provide duct access doors of one of the following:
1. Air Balance Inc.
 2. Duro Dyne Corp.
 3. Register & Grille Mfg. Co., Inc.
 4. Metalaire.
 5. Ruskin Mfg. Co.
 6. Ventfabrics, Inc.

2.6 FLEXIBLE CONNECTIONS

- A. General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.
- B. Manufacturers: Subject to compliance with requirements, provide flexible connections of one of the following:
1. American/Elgen Co.; Energy Div.
 2. Duro Dyne Corp.
 3. Flexaust (The) Co.
 4. Ventfabrics, Inc.

2.7 FLEXIBLE DUCTS

- A. General: Comply with UL 181, Class 1.
- B. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-1/2 inch-thick, glass fiber insulation around a continuous inner liner.
1. Insulation: Minimum of 1-1/2-inch nominal thickness, 1-1/2-pound density per cubic foot insulation. The insulation shall be sheathed with a vapor barrier having a maximum permeability of 0.02 perms per ASTM E 96. Ends of insulation shall be coated with cement to prevent erosion and delamination
 2. Inner Liner: Aluminum convoluted cores with airtight mechanical locks.
- C. Pressure Rating: 6-inch wg positive, 2-inch wg negative.

PART 3 EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA "HVAC Duct Conduction Standards Metal and Flexible", and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.3 INSTALLATION OF FIRE AND SMOKE DAMPERS

- A. Install dampers in accordance with manufacturers' installation details, SMACNA guide, and as detailed on Drawings complying with NFPA No. 90A. Dampers to be installed with steel sleeves and perimeter angles on both sides of the opening so that damper will stay in place in the protected opening even though the duct may become disturbed during the fire. Ducts to terminate at fire damper sleeves and connection between ducts and sleeves to be by "S" type or approved slip joints. Install dampers such that blade lock is located on the accessible side.
- B. Provide fire dampers in all transfer openings and ducts passing through or penetrating fire rated assemblies (walls, partitions, decks, etc..).
- C. Provide smoke dampers in all transfer openings and all ducts passing through smoke partitions. Provide smoke dampers on the ductwork connections of all air handling equipment rated 15,000 CFM or greater.
- D. Review the architectural plans to confirm the fire and smoke ratings of the assemblies and provide fire, smoke, or combination fire/smoke dampers at all penetrations of these assemblies, as described above, whether the dampers are indicated on the mechanical floor plans or not. No reference in the SMACNA standard shall be interpreted to eliminate this requirement.

3.4 ALLOWANCE:

- A. In addition to the requirements for fire, smoke, and combination fire smoke dampers discussed above, provide up to ten additional dampers of each type for any size

required, installed and complete with access doors and completely functional in all manner, to be used at the discretion of the Engineer.

3.5 INSTALLATION OF TURNING VANES

- A. Install turning vanes in all mitered elbows unless a drawing note specifically instructs to not provide turning vanes at a specific location.

3.6 INSTALLATION OF DUCT ACCESS DOORS

- A. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
- B. Install at all duct heating coils (inlet side), motorized volume dampers, fire dampers, smoke dampers, control equipment, smoke detectors, etc. Locate doors to permit inspection and maintenance of equipment.
- C. Duct Cleaning Provisions: Install access doors at unit connection (both sides) and at 50-foot intervals. Locate on sides of duct (except when not accessible).

3.7 INSTALLATION OF FLEXIBLE CONNECTIONS

- A. Construct rectangular connections to ducts from fans and equipment with steel clamping bands and angle iron framing, and adhesive for an air tight connection allowing one inch slack in the fabric.

3.8 INSTALLATION OF FLEXIBLE DUCTS

- A. Install flexible ducts in accordance with SMANCA standards. Limit flexible duct lengths to no more than four feet. Provide adequate supports to achieve no more than 1" of deflection.

3.9 FIELD QUALITY CONTROL

- A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

3.10 ADJUSTING AND CLEANING

- A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.

- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.11 EXTRA STOCK

- A. Furnish extra fusible links to Owner, one link for every 10 installed of each temperature range; obtain receipt.

END OF SECTION

SECTION 233319 – DUCT SILENCERS

PART 1 GENERAL

1.1 RELATED SECTIONS

- A. The following sections contain requirements that relate to this section:
 - 1. Section 013000 - Administrative Requirements
 - 2. Section 014000 - Quality Requirements
 - 3. Section 017419 - Construction Waste Management and Disposal
 - 4. Section 017800 - Closeout Submittals.
 - 5. Section 017900 - Demonstration and Training
 - 6. Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment.
 - 7. Section 233100 - HVAC Ducts and Casings
 - 8. Section 233300 - Air Duct Accessories

1.2 REFERENCE STANDARDS

- A. ASHRAE Applications Handbook, Chapter 48 “Noise and Vibration Control”; 2015
- B. ASHRAE 62.1 Ventilation for Acceptable Indoor Air Quality; 2013
- C. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-dip Process; 2015
- D. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2016
- E. ASTM E477-13 Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers; 2013
- F. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015
- G. NFPA 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2015
- H. NFPA 255 Standard Method of Test of Surface Burning Characteristics of Building Materials; 2006
- I. SMACNA 006-2006 HVAC Duct Construction Standards – Metal and Flexible; 2006

- J. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials; 2008

1.3 SUBMITTALS

- A. See Section 013000 – Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Silencer manufacturer to provide submittal drawings detailing all duct silencer data specified in the mechanical drawing schedule.
 - 2. Silencer manufacturer shall submit certified laboratory performance obtained using ASTM E477-13. The laboratory must be NVLAP accredited for the ASTM E477-13 test standard and a copy of the accreditation certificate must be included with submittals. Data from non-NVLAP accredited test facilities is not acceptable.
 - 3. Submitted silencer pressure drops should not exceed those listed in the silencer schedule unless approved by project engineer. Silencer pressure drop measurements shall be made in accordance with ASTM E477-13.
 - 4. Submitted silencer dynamic insertion loss and self-noise data should satisfy values listed in the silencer schedule at the project's air distribution system airflow requirements. ASTM E-477-13 tests to obtain this data shall be conducted in the same facility and utilize the same silencer.
 - 5. Silencer dynamic insertion loss shall not be less than that listed in the silencer schedule unless approved by the project engineer.
 - 6. Silencer generated noise shall not be greater than that listed in the silencer schedule unless approved by the project engineer.
 - 7. The silencer manufacturer shall provide, for approval, acoustic calculations for relevant duct systems with silencers to validate that the submitted silencers will satisfy occupied space design guidelines. Use sound power levels of actual equipment scheduled for installation on project. Acoustic Analysis shall include breakout noise calculations as required. In the absence of specified background noise level criteria, the guidelines outlined in the 2015 ASHRAE Applications Handbook Chapter 48, Table 1 shall apply.
 - 8. Silencer manufacturer shall provide test data for silencer(s) as indicated in the silencer schedule if requested by the project engineer that complies with project criteria.

1.4 QUALITY CONTROL

- A. Silencers shall be installed in accordance with NFPA 90A and with NFPA 90B.
- B. Silencer performance must have been substantiated in a duct-to-reverberant room test facility in accordance with ASTM E477-13. The test facility must provide airflow in both directions through the test silencer. The test set-up shall eliminate effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption. The aero-

acoustic laboratory must be currently NVLAP accredited for ASTM E477-13. Test facilities and reports shall be open to inspection from project engineer.

- C. Silencer manufacturer must have a minimum ten (10) years of industry experience.
- D. Silencer manufacturer shall provide a copy of their laboratory NVLAP accreditation certificate for the ASTM E-477-13 test standard with the submittals. Data from non-NVLAP accredited test facilities is not acceptable.
- E. The silencer manufacturer shall test silencer(s) as indicated in the silencer schedule if required and at owner's expense. Project engineer shall be notified of the test date in advance and tests shall comply with the project criteria.

1.5 WARRANTY

- A. Provide 12-month manufacturer warranty from date of shipment for duct silencers.
- B. See Section 01 78 00 – Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.1 DUCT SILENCERS

- A. Basis of Design: Price Industries
 - 1. Absorptive Circular Silencer: Model CS
 - 2. Absorptive Elbow Silencer: Models ERM/ERMX
 - 3. Absorptive Rectangular Silencer: Models RL/RM/RH/RLX/RMX/RHX
 - 4. Axial Fan Silencer: Model AFS
 - 5. Film Lined Circular Silencer: Model CS
 - 6. Film Lined Elbow Silencer: Models ERMT/ERMTX
 - 7. Film Lined Rectangular Silencer: Models RLT/RMT/RHT/RLTX/RMTX/RHTX
 - 8. Packless Circular Silencer: Models PCLS/PCLB/PCMS/PCMB/PCHS/PCHB
 - 9. Packless Elbow Silencer: Model PERM
 - 10. Packless Elbow Circular Silencer: Models PECLS/PECLB/PECMS/PECMB/PECHS/PECHB
 - 11. Packless Rectangular Silencer: Model RSP
- B. Alternate Manufacturers:
 - 1. Kinetics Noise Control.
 - 2. Vibro Acoustics.
 - 3. Alternate manufacturers must obtain written approval by the project engineer to bid.

4. As a condition of pre-approval, alternate manufacturers must submit to the project engineer HVAC silencer test reports for a silencer tested in accordance with ASTM E477-13 in a test facility that is NVLAP-accredited for ASTM E477-13.
5. A copy of the laboratory's current NVLAP accreditation certificate must be included with submitted reports and any changes to the specifications must be submitted and approved in writing by the project engineer prior to the bid due-date.

2.2 GENERAL:

- A. Silencers shall be of the size, configuration, capacity and acoustic performance as scheduled on the drawings. Silencers shall be fabricated by the same manufacturer.
- B. Silencer inlet and outlet connection dimensions must be equal to the duct sizes shown on the drawings. Duct transitions at silencers are not permitted unless shown on the contract drawings or approved by the project engineer.

2.3 CONSTRUCTION:

- A. Silencers shall be constructed in accordance with ASHRAE and SMACNA Standards for the pressure and velocity classification specified for the air distribution system installed.
- B. Casing seams and joints shall be lock-formed and sealed or stitch welded and sealed except as noted, to provide leakage-resistant construction.
- C. Airtight construction shall be achieved by use of a duct-sealing compound supplied and installed by the contractor at the jobsite.
- D. Perforated steel shall be adequately stiffened to insure flatness and form. Spot welds shall be painted as required.
- E. Fire-Performance Characteristics: Silencer assemblies, including acoustic media fill, natural cotton fiber, sealants and acoustical spacers shall have Class 1 flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E84, NFPA 255 or UL 723.
- F. Material gauge thickness:
 1. Material gauges noted in other sections are minimums and shall increase as required for the system pressure and velocity classification.
 2. The silencers shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge.

- G. Outer casing shall be ASTM A 653/A 653M, G90 galvanized sheet steel, gauge as listed below:
1. Rectangular Silencers, including STC-rated models: 22 gauge
 2. Rectangular Elbow Silencers: 22 gauge
- H. Circular Silencers:
1. For units up to 20 inches in diameter: 22 gauge
 2. For units 21 through 44 inches in diameter: 18 gauge
 3. For units over 44 inches in Diameter: 16 gauge
- I. Rectangular Elbow Silencers: Acoustical splitter/baffles shall be internally radiused and aerodynamically designed for efficient turning of the air.
- J. Transitional Silencers: Transitioning shall occur internal to the silencer such that the height of the gap or air passage is changing with the length of the splitters/baffles.
- K. Inner perforated metal liner shall be supplied in accordance with ASTM A 653/A 653M, G90 galvanized sheet steel in the following gauge thicknesses according to silencer type or connection size:
1. Rectangular Silencers: 22 gauge
 2. Rectangular Elbow Silencers: 22 gauge
 3. Circular Silencers: 22 gauge
 4. Transitional Silencers: 22 gauge
- L. Principal Sound-Absorbing Mechanism: Packless (No-Media) Silencers: Models shall not contain absorptive media. Attenuation shall be achieved with controlled impedance membranes and broadly tuned resonators.
- M. Absorptive (Dissipative) and Film Lined Silencers:
1. Standard Acoustic media:
 - a. Media shall be of acoustic quality, shot-free glass fiber insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall be as required to insure conformance with laboratory test data.
 - b. Media shall be packed with a minimum of 15% compression during silencer assembly.
 - c. Media shall be resilient such that it will not pull apart during normal applications, and shall resist settling, breakdown, and sagging from vibration. Media shall not rot, mildew, or otherwise deteriorate, and shall have sufficient flexibility to readily form around corners and curved surfaces.
 - d. Media shall not cause or accelerate corrosion of aluminum or steel.

N. Natural cotton and film lined natural cotton:

1. Media shall be natural cotton fibers treated with an EPA registered, non-toxic borate solution, and “flash dried” to actively inhibit the growth of mold, mildew, bacteria, and fungi.
2. Media shall not contain formaldehydes, phenolic resins or Volatile Organic Compounds (VOC’s) that can off-gas and/or cause health concerns.
3. Media shall be 100% recyclable and comply with UL181 and NFPA 90A. Insulation shall be packed with a minimum of 15% compression during silencer assembly.
4. Media shall not cause or accelerate corrosion of aluminum or steel. Glass fiber, fiberglass and mineral wool are not permitted as a substitute for natural cotton.

2.4 MEDIA PROTECTION:

A. Dissipative silencers:

1. Where indicated on the silencer schedule, media shall be encapsulated in glass fiber cloth to help prevent shedding, erosion and impregnation of the glass fiber.
2. Axial Fan silencers shall have a glass fiber cloth liner.

B. Film Lined silencers:

1. The acoustic media shall be completely wrapped with polymer film to help prevent shedding, erosion and impregnation.
2. The wrapped acoustic media shall be separated from the perforated metal by a factory-installed acoustically transparent spacer.
3. The spacer shall be flame retardant and erosion resistant.
4. Mesh, screen or corrugated perforated liner will not be acceptable as a substitute for the specified spacer.
5. Silencer manufacturer shall provide a written test report showing silencer assemblies have Class 1 flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84, NFPA 255 or UL 723.

C. HTL Casings:

1. Where indicated on the silencer schedule, silencers shall have high transmission loss (HTL) walls externally applied and completely sealed to the silencer casing by the silencer manufacturer.
2. If requested by the project engineer, relevant breakout noise calculations shall be provided to ensure compliance with the relevant room noise criteria that are based on the sound power levels of the specified equipment.

2.5 SHIPPING PROTECTION:

- A. Silencers shall be shipped with factory-installed end caps.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install silencer according to manufacturer's written installation instructions.
- B. Support duct silencers independently from ductwork.
- C. Ensure duct silencers are installed with airflow arrows in direction of airflow.

3.2 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals for closeout submittals.
- B. See Section 017900 - Demonstration and Training for additional requirements.

END OF SECTION

SECTION 235190 - MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. This section is complementary to Division 23 Basic Mechanical Materials and Methods section, and is part of each Division 23 section making reference to identification devices specified herein.

1.2 SUMMARY

- A. Extent of mechanical identification work required by this section is indicated on drawings and/or specified in other Division 23 sections.
- B. Types of identification devices specified in this section include the following:
 - 1. Engrave plastic laminate labels.
 - 2. Plastic Pipe Markers.
 - 3. Underground-Type Plastic Line Marker.
 - 4. Plastic Duct Markers.
 - 5. Valve Tags.
 - 6. Valve Schedule Holders
 - 7. Ceiling Markers
- C. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Other Division 23 sections for mechanical identification furnished as part of factory-fabricated equipment assembly.
 - 2. Section 235250, Mechanical Insulation, for PVC jacketing of piping and equipment installed in all mechanical/utility rooms, and in all exposed locations. Colors of jacketing are specified in this section; match the colors of the plastic duct markers.
 - 3. Division 26 sections for identification requirements of electrical work; not work of this Section.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.
- C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2 inch x 11 inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.
- D. Maintenance Data: Include product data and schedules in maintenance manuals; in accordance with requirements of Division 1.
- E. Quality Assurance Reports: Submit a report for every quality assurance test.
- F. Material Safety Data Sheets (MSDS) for all applicable products to PGCPs Environmental Health and Safety Office.

1.4 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide mechanical identification materials of one of the following:
 - 1. Allen Systems, Inc.
 - 2. Brady (W.H.) Co.; Signmark Div.
 - 3. Industrial Safety Supply Co., Inc.
 - 4. Seton Name Plate Corp.

2.2 MECHANICAL IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than single type is specified for application, selection is Installer's option, but provides single selection for each product category.

2.3 ENGRAVED PLASTIC LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with the engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/16" for units up to 20 square inches or 8 inches in length; 1/8" for larger units.
- C. Fasteners: Self-tapping stainless steel screws, except contact type permanent adhesive where screws cannot or should not penetrate the substrate.

2.4 CEILING MARKERS

- A. Engraved plastic laminate sign screwed on ceiling grid or ceiling access door to indicate location. Comply with requirements for engrave plastic laminate signs.

2.5 PLASTIC PIPE MARKERS

- A. Pressure-Sensitive Type: Provide manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1.
- B. Pipes: For external diameters less than 6 inch (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - 1. Adhesive lap joint in pipe marker overlap.
 - 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inch.
- C. Lettering: Comply with piping system nomenclature as specified, scheduled or shown on the drawings, and abbreviate only as necessary for each application length.
- D. Color Coding: Obtain and conform to Prince George County Public Schools color code. Coordinate the color coding of the pipe markers with that of the plastic pipe covers to be provided in all major mechanical rooms and locations indicated on the drawings.
- E. Arrows: Provide each pipe marker with printed arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.6 PLASTIC DUCT MARKERS

- A. General: Provide manufacturer's standard laminated plastic, color coded duct markers. Obtain and conform to Prince George County Public Schools color code.
- B. Nomenclature: Include the following:
 - 1. Direction of air flow.
 - 2. Duct service (supply, return, exhaust, etc.).

2.7 UNDERGROUND-TYPE PLASTIC LINE MARKERS

- A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6 inch wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.
 - 1. Provide multiply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

2.8 VALVE TAGS

- A. Plastic Valve Tags: Provide manufacturer's standard solid plastic valve tags with printed enamel lettering, with piping system abbreviation in approximately 3/16 inch high letters and sequenced valve numbers approximately 3/8 inch high, and with 5/32 inch hole for fastener. Provide 1-1/8 inch sq. white tags with black lettering.
- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

2.9 VALVE SCHEDULE HOLDERS

- A. For each page of valve schedule, provide flexible plastic envelopes with reinforced three-ring punching.
- B. Provide a picture frame style frame with Plexiglas cover.

2.10 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

- B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, installs identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 DUCTWORK IDENTIFICATION

- A. General: Identify air supply, return, exhaust, intake and relief ductwork with duct markers and arrows, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork color).
- B. Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50 feet spacings along exposed runs.

3.3 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
 - 1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
- B. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
 - 1. Near each valve and control device.
 - 2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - 3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 - 4. At access doors, manholes and similar access points which permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.
6. Spaced intermediately at maximum spacing of 50 feet along each piping run, except reduce spacing to 25 feet in congested areas of piping and equipment.
7. On piping above removable acoustical ceilings, space at 20 feet maximum.

3.4 UNDERGROUND PIPING IDENTIFICATION

- A. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6 to 8 inches below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16 inch, install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.5 VALVE IDENTIFICATION

- A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system. Provide one copy of the valve schedule in each O&M manual and one copy installed in the frame under Plexiglas and securely mounted to the mechanical room wall in a location approved by the owner.

3.6 MECHANICAL EQUIPMENT IDENTIFICATION

- A. General: Install engraved plastic laminate marker on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment:
 1. Fuel-burning units including heaters, ventilation units, and water heaters.
 2. Pumps, compressors, and similar motor-driven units.
 3. Coils, evaporators, and similar equipment.
 4. Fans, blowers, primary balancing dampers and mixing boxes.
 5. Air handling units, heat pump units, and fans.
 6. Tanks and pressure vessels.

3.7 CEILING ACCESS IDENTIFICATION

- A. General: Install ceiling markers on ceiling tile, adjacent exposed grid support member, or access door to indicate which ceiling panel is to be removed to obtain access to the following ceiling concealed items:

1. Equipment
2. Tagged valves
3. Control dampers
4. Fire and/or smoke dampers
5. Duct smoke detectors
6. Coils.
7. Control system panels.

- B. Provide the name, designation, and/or valve tag number for each concealed item engraved on the marker.

3.8 ADJUSTING AND CLEANING

- A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
- B. Cleaning: Clean face of identification devices.

END OF SECTION

SECTION 235216 - CONDENSING BOILER

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes condensing boiler, trim, and accessories for generating hot water.

1.3 SUBMITTALS

- A. Product Data for each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boiler.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings for boiler, boiler trim, and accessories.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates:
 - 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
 - 2. CSA B51 pressure vessel Canadian Registration Number (CRN).

1.5 CLOSEOUT SUBMITTALS

CONDENSING BOILER

- A. Operation and Maintenance Data: For boiler to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boiler that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Condensing Boiler:
 - a. Leakage and Materials: 5 years from date of Substantial Completion.
 - b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated for five years from the date of Substantial Completion Certificate.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label boiler to comply with 2010 ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil-Fired Boilers - Minimum Efficiency Requirements."
- D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N.
- E. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and tekabeled by a testing agency acceptable to authorities having jurisdiction.
- F. CSA Compliance: Test boilers for compliance with CSA B51.
- G. Mounting Base: For securing boiler to concrete base.
- H. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration Controls" when mounting base is anchored to building structure.

2.2 CONDENSING BOILER

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:

CONDENSING BOILER

1. Lochnivar
2. Weil-Mclain
3. Raypack
 - a. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber.
 - b. Pressure Vessel: Carbon steel with welded heads and tube connections.
 - c. Burner: Natural gas, forced draft.
 - d. Blower: Centrifugal fan to operate during each burner firing sequence and to pre-purge and post purge the combustion chamber.
 - 1) Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230030 "Electrical Requirements for Mechanical Equipment."
 - 2) Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - e. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
 - f. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
 - g. Casing:
 - 1) Jacket: Sheet metal, with snap-in or interlocking closures.
 - 2) Control Compartment Enclosures: NEMA 250, Type 1A.
 - 3) Finish: Baked-enamel protective finish.
 - 4) Insulation: Minimum 2-inch-thick, mineral-fiber insulation surrounding the heat exchanger.
 - 5) Combustion-Air Connections: Inlet and vent duct collars.
 - h. Capacities and Characteristics: See drawing schedules for information.

2.3 TRIM

- A. Include devices sized to comply with ASME B31.1 and ASME B31.9.
- B. Aquastat Controllers: Operating high limit.
- C. Safety Relief Valve: ASME rated.
- D. Pressure and Temperature Gage: Minimum 3-1/2-inch-diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.
- E. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- F. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

CONDENSING BOILER

- G. Water Column: Minimum 12-inch glass gage with shutoff cocks.
- H. Drain Valves: Minimum NPS 3/4 or nozzle size with hose-end connection.
- I. Blowdown Valves: Factory-installed bottom and surface, slow-acting blowdown valves same size as boiler nozzle. Blowdown valves shall be combination of slow and quick acting as required by ASME B31.1.
- J. Boiler operating controls shall include the following devices and features:
 - 1. Control transformer.
 - 2. Set-Point Adjust: Set points shall be adjustable.
 - 3. Operating Pressure Control: Factory wired and mounted to cycle burner.
 - 4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.
 - 5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 10 deg F outside-air temperature, set supply-water temperature at 160 deg F; at 35 deg F outside-air temperature, set supply-water temperature at 120 deg F. Include automatic, modulating firing sequence for boiler to ensure maximum system efficiency throughout the load range.
 - 6. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.
 - 7. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
 - a. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature.
 - b. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
 - c. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
 - d. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
 - e. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
 - f. Hardwired Points:
 - 1) Monitoring: On/off status, common trouble alarm.
 - 2) Control: On/off operation, hot-water-supply temperature set-point adjustment.
 - g. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

CONDENSING BOILER

2.4 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
- C. House in NEMA 250, Type 1 enclosure.
 - 1. Wiring shall be numbered and color coded to match wiring diagram.
 - 2. Install factory wiring outside of an enclosure in a metal raceway.
 - 3. Field power interface shall be to fused disconnect switch
 - 4. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
 - 5. Provide each motor with overcurrent protection.

2.4 VENTING KITS

- A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.
- B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.4 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boiler, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.
- C. Allow Department access to source quality-control testing of boiler. Notify Professional 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.

CONDENSING BOILER

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boiler will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Equipment Mounting:
 1. Install boiler on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations.
 2. Comply with requirements for vibration isolation and seismic-restraint devices specified in Section 230548 "Vibration Controls."
- B. Install gas-fired boiler according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boiler, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 230510 "Hydronic Piping Specialties."
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Install piping from safety valves to drip-pan elbow and to nearest floor drain.

CONDENSING BOILER

- I. Boiler Venting:
 - 1. Install flue venting kit and combustion-air intake.
 - 2. Connect full size to boiler connections.
- J. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- K. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 SEQUENCE OF OPERATIONS

- A. Boiler:
 - 1. Upon a call for heat, the gas pressure switches must be closed. Once the gas pressure switches are closed, the control turns on the appropriate pump system and boiler pumps for space heating, DWH pump. The flow switch and/or LWCO must close.
 - 2. The control turns on power to the louver relay. The auxiliary louver switch and air pressure switch must close.
 - 3. The control starts the prepurge cycle by initiating the blower.
 - 4. The control starts the trial for ignition by firing the spark electrode and opening the gas valve.
 - 5. If flame is not detected after the sparking ends, the control will perform a post purge then start another prepurge cycle and try to light the burner again. The control will perform a total of 4 attempts before locking out.
 - 6. If flame is detected, it holds the firing rate steady for a few seconds to let the flame stabilize, then it begins to modulate the firing rate based on a set point or some other command such as a 0-10V BMS signal.
 - 7. If the space heating call for heat is active, and the tank thermostat or sensor starts a DHW call for heat, the boiler will switch to the DHW mode. If programmed for normal DHW operation, the DHW pump will turn on first then the boiler pump will turn off. This will divert the boiler's outlet water from the heating system and send it to the tank coil instead. The control will then modulate to maintain the outlet temperature to the DHW boiler setpoint.
 - 8. If the boiler is not part of a Cascade, and both the space heating and DHW calls for heat remain active long enough, the boiler will switch back and forth between the two heating modes until one of them is satisfied. Once both calls for heat are satisfied, the control will turn off the burner. The blower will continue to run during the post purge period.
 - 9. Any pumps that are running will continue to run for their respective pump delay times before turning off, unless programmed to remain on continuously. A 60 second anti-cycle period will start, which will delay any new call for heat until it times out.
 - 10. In Standby mode: Ready to start a new cycle

CONDENSING BOILER

B. Snow Melting

1. Two pumps are provided. One is designated as the primary pump, the other is designated as the standby pump. On a call for operation, the primary pump shall start and operate continuously. The designation of each pump shall alternate on a weekly basis. On a change in designation, the standby pump shall be energized. Once flow is proven via the pump flow switch, the other pump shall be deenergized.
2. Proof of flow: Each pump is provided with a flow switch to prove flow. Upon a pump being energized, if flow is not proven within 20 seconds and while a pump is energized, if failure of flow proof occurs for 20 seconds, the following shall occur:
 - a. The primary pump shall be deenergized.
 - b. The standby pump shall be energized.
 - c. A pump failure alarm shall be initiated.
 - d. A service work order shall be printed.
3. When the call for operation ceases, the pump shall be deenergized.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 1. Perform installation and startup checks according to manufacturer's written instructions.
 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- D. Boiler will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

CONDENSING BOILER

G. Performance Tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boiler shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boiler.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at 40, 60, 80, 100 percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
7. Notify Professional 48 hours minimum in advance of test dates.
8. Document test results in a report and submit to Professional.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train DGS 's maintenance personnel to adjust, operate, and maintain boiler. Refer to Section 017900 "Demonstration and Training."

END OF SECTION

SECTION 235250 - MECHANICAL INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 23 Sections apply to this section:
 - 1. "Basic Mechanical Requirements."
 - 2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY

- A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of mechanical insulation specified in this section include the following:
 - 1. Piping System Insulation:
 - a. Fiberglass
 - b. Cellular Glass
 - c. Calcium Silicate
 - d. Flexible Unicellular
 - 2. Ductwork System Insulation: Fiberglass.
 - 3. Equipment Insulation:
 - a. Fiberglass.
 - b. Calcium Silicate
 - c. Flexible Unicellular.
- C. Related Sections: The following Sections contain requirements that relate to this Section.
 - 1. Division 230529 section "Supports and Anchors" for protection saddles, protection shields, and thermal hanger shields; not work of this section.
 - 2. Division 233113 section "Metal Ductwork" for duct linings; not work of this section.
 - 3. Division 230190 section "Mechanical Identification" for installation of identification devices for piping, ductwork, and equipment; not work of this section.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.
- B. Material Safety Data Sheets (MSDS) for all applicable products to Montgomery County Environmental Health and Safety Office.

1.4 QUALITY ASSURANCE

- A. Installer's Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.
- B. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastic and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
 - 1. Armstrong World Industries, Inc.
 - 2. Babcock & Wilcox; Insulating Products Div.
 - 3. CertainTeed Corp.
 - 4. Knauf Fiber Glass GmbH.
 - 5. Manville Products Corp.
 - 6. Owens-Corning Fiberglass Corp.
 - 7. Pittsburgh Corning Corp.
 - 8. Rubatex Corp.

2.2 PIPING INSULATION MATERIALS

- A. Fiberglass Piping Insulation: ASTM C 547, Class 1 unless otherwise indicated.
- B. Calcium Silicate Piping Insulation: ASTM C 533, Type I.
- C. Cellular Glass Piping Insulation: ASTM C 552, Type II, Class 2.
- D. Flexible Unicellular Piping Insulation: ASTM C 534, Type I.
- E. Jackets for Piping Insulation: ASTM C 921, Type I for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installers option.
 - 1. Encase fiberglass and calcium silicate pipe fittings insulation with one-piece pre-molded PVC fitting covers, fastened as per manufacturer's recommendations.
 - 2. Encase exterior piping insulation with aluminum jacket with weather-proof construction.
- F. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.
- G. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

2.3 DUCTWORK INSULATION MATERIALS

- A. Rigid Fiberglass Ductwork Insulation: ASTM C 612, Class 1.
- B. Flexible Fiberglass Ductwork Insulation: ASTM C 553, Type I, Class B-4.
- C. Flexible Unicellular Ductwork Insulation: ASTM C 534, Type II.
- D. Jackets for Ductwork Insulation: ASTM C 921, Type I for ductwork with temperatures below ambient; Type II for ductwork with temperatures above ambient.
- E. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.
- F. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

2.4 EQUIPMENT INSULATION MATERIALS

- A. Rigid Fiberglass Equipment Insulation: ASTM C 612, Class 2.

- B. Flexible Fiberglass Equipment Insulation: ASTM C 553, Type I, Class B-4.
- C. Calcium Silicate Equipment Insulation: ASTM C 533, Type I, Block.
- D. Flexible Unicellular Equipment Insulation: ASTM C 534, Type II.
- E. Jacketing Material for Equipment Insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or aluminum jacket at Installer's option, except as otherwise indicated.
- F. Equipment Insulation Compounds: Provide adhesives, cements, sealers, mastic and protective finishes as recommended by insulation manufacturer for applications indicated.
- G. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

PART 3 EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PLUMBING PIPING SYSTEM INSULATION

- A. Insulation Omitted: Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre-insulated equipment.
- B. Cold Piping Application Requirements: Insulate the following cold plumbing piping systems:
 - 1. Interior above-ground potable cold-water piping.
 - 2. Interior above-ground storm water piping (rain water conductors).
- C. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
 - 1. Fiberglass: 1/2-inch thickness.
 - 2. Flexible Unicellular: 1/2-inch thickness, only for runouts in walls.

- D. Hot Piping Application Requirements: Insulate the following hot plumbing piping systems:
1. Interior above-ground potable hot water piping.
 2. Interior above-ground potable hot water recirculating piping.
 3. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
 4. Fiberglass: 1 inch thick for pipe sizes up to and including 4 inch, 1-1/2 inch thick for pipe sizes over 4 inch
 5. Flexible Unicellular: 1/2-inch thickness, only for runouts in walls.
- E. Cold Piping Underground Application Requirements: Insulate the following cold plumbing piping systems:
1. Below-ground potable cold water piping.
 2. Insulate each piping system specified above with:
 3. Cellular Glass: 1/2-inch thickness and install in water-tight PVC sleeve.
- F. Hot Piping Underground Application Requirements: Insulate the following hot plumbing piping systems:
1. Below-ground potable hot water piping.
 2. Below-ground potable hot water recirculating piping.
 3. Source Water
 4. Insulate each piping system specified above with:
 5. Cellular Glass: 1/2-inch thickness and install in water-tight PVC sleeve.

3.3 HVAC PIPING SYSTEM INSULATION

- A. Insulation Omitted: Omit insulation on hot piping within radiation enclosures or unit cabinets; on cold piping within unit cabinets provided piping is located over drain pan; on unions, flexible connections, and expansion joints.
- B. Cold Piping (40-degree F to ambient) Application Requirements: Insulate all cold HVAC piping, including but not limited to the following piping systems:
1. Air conditioner condensate drain piping.
 2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
 - a. Fiberglass: 1 inch thick for pipe sizes up to and including 6 inch, 1-1/2 inch thick for 8 inch and larger.
 - b. Fiberglass: 1 inch thickness, only for runouts in walls.
 - c. 1" thicker than designated for a. And b. if piping located outdoors.

- C. Hot Low-Pressure Piping (to 250 deg. F). Above Ground Application Requirements: Insulate all hot low pressure HVAC piping systems including but not limited to the following:
1. Hot gas refrigerant piping.
 2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
 - a. Fiberglass: 1 inch thick for pipe sizes up to and including 1 inch, 1-1/2 inch thick for pipe sizes 1 inch through 2-inch, 2 inch thick for pipe over 2-1/2 inch through 6 inch, 2-1/2 inch for pipes 8 inch and larger.
 - b. Fiberglass: 1 inch thickness for runouts in walls.
 - c. 1" thicker than designated in a. and b. if the piping is located outdoors.
- D. Insulate each piping system specified above with the following type and thickness of insulation:
1. Cellular Glass: 2-inch thickness with finish cover of "Pittwrap" jacketing.

3.4 DUCTWORK SYSTEM INSULATION

- A. Insulation Omitted: Do not insulate fibrous glass ductwork, or lined ductwork.
- B. Cold Ductwork (Below Ambient Temperature) Application Requirements: Insulate the following cold ductwork:
1. Outdoor air intake ductwork between air entrance and fan inlet or HVAC unit inlet.
 2. HVAC supply ductwork between fan discharge, or HVAC unit discharge, and room terminal outlet.
 3. HVAC return ductwork in mechanical equipment rooms.
 4. HVAC plenums and unit housings not pre-insulated at factory or lined.
 5. Insulate each ductwork system specified above with one of the following types and thicknesses of insulation:
 - a. Rigid Fiberglass: 1-1/2 inch thick, for exposed ductwork, etc.
 - b. Flexible Fiberglass: 1-1/2 inch thick, application limited to concealed locations.
 - c. Outdoor ductwork: 2 1/2" thick for all applications
- C. Hot Ductwork (Above Ambient Temperature) Application Requirements: Insulate the following hot ductwork:
1. Hot supply ductwork between fan discharge, or heating unit discharge, and room terminal outlet.
 2. Heating plenums and unit housings not pre-insulated at factory or lined.
 3. Insulate each ductwork system specified above with one of the following types and thicknesses of insulation:

- a. Rigid Fiberglass: 1-1/2 inch thick, for exposed ductwork, etc.
- b. Flexible Fiberglass: 1-1/2 inch thick, application limited to concealed locations.
- c. Outdoor ductwork: 2 1/2" thick for all applications.

3.5 EQUIPMENT INSULATION

- A. Cold Equipment (Below Ambient Temperature) Application Requirements: Insulate the following cold equipment:
 1. Refrigeration equipment, including pumps.
 2. Drip pans under chilled equipment.
 3. Cold water pumps.
 4. Roof drain bodies.
 5. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:
 - a. Fiberglass: 1 inch thick for surfaces above 40 deg. F (2 deg. C) and 1-1/2 inch thick for surfaces 40 deg. F (2 deg. C) and lower.
 - b. Flexible Unicellular: 1 inch thick.
- B. Hot Equipment (Above Ambient Temperature) Application Requirements: Insulate the following hot equipment:
 1. Water heaters (not pre-insulated at factory).
 2. Insulate each item of equipment specified above with Fiberglass: 2 inch thick.

3.6 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

- F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.
- G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- H. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3-inch-wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3-inch-wide vapor barrier tape or band.

3.7 INSTALLATION OF DUCTWORK INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation materials with smooth and even surfaces.
- C. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- D. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.
- E. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.
- F. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed.
- G. Corner Angles: Install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

3.8 INSTALLATION OF EQUIPMENT INSULATION

- A. General: Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.
- B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.

- C. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.
- D. Do not apply insulation to equipment, breechings, or stacks while hot.
- E. Apply insulation using staggered joint method for both single- and double-layer construction, where feasible. Apply each layer of insulation separately.
- F. Coat insulated surfaces with layer of insulating cement, trowled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
- G. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2 inches. Apply over vapor barrier where applicable.
- H. Do not insulate boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.
- I. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, accessories and pumps.

3.9 OUTDOOR INSULATION FINISH

- A. General: Piping, ductwork and equipment exposed to weather shall have insulation protective finish or jacketing installed as recommended by manufacturer.
- B. Piping: Pipe shall have aluminum jacket with moisture barrier with locking longitudinal seam and butt straps. Fittings, valves, flanges, etc. shall have factory or job fabricated aluminum cover secured with banding and/or screws.
- C. Round ductwork: Same finish as piping.
- D. Rectangular ductwork and equipment: Shall have white vinyl acrylic mastic applied in two coats and reinforced with glass cloth membrane.

3.10 EXISTING INSULATION REPAIR

- A. Repair damaged sections of existing mechanical insulation, both previously damaged or damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.11 PROTECTION

- A. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION

SECTION 235932 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 23 Sections apply to this section:
 - 1. "Basic Mechanical Requirements."
 - 2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY

- A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.
- B. Types of air outlets and inlets required for project include the following:
 - 1. Supply air diffusers.
 - 2. Return and exhaust air registers and grille.
 - 3. Linear supply and return air slot diffuser.
 - 4. Air intake and exhaust air Louvers.
- C. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Other Division 23 sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this section.
 - 2. Other Division 23 sections for balancing of air outlets and inlets; not work of this section.

1.3 MANUFACTURER

- 1. Price
- 2. Metalaire
- 3. Titus

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
 2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
- B. Samples: Submit 3 samples of each type of finish furnished for each prefinished louver.
- C. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.
- D. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

1.5 QUALITY CONTROL

- A. Codes and Standards:
1. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets."
 2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets."
 3. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual."
 4. ADC Seal: Provide air outlets and inlets bearing ADC Certified Rating Seal.
 5. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.
- B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Supply air ceiling diffusers, registers and grilles shall be of capacities and sizes as scheduled on the drawings; of manufacturer's type as scheduled, or approved equal.

- B. Air outlets and inlets shall be of suitable size to suit the duct opening to which they are attached and the surface on which they are to be mounted. Adapters of other field-fabricated devices will not be accepted. Registers, grilles and their appurtenances shall be installed in an airtight manner without discernible leakage at joints or seams.
 - 1. Registers shall be equipped with internal air volume control devices, operable through the exposed face. Supply registers shall be equipped with multi-directional air flow vanes.
 - 2. Wherever special keys or operators are required for adjustment of the devices, this Contractor shall furnish the Owner with two of each type.
- C. All air outlets and inlets shall be of aluminum construction unless otherwise designated on the drawings.
- D. Louvers:
 - 1. All louvers shall be constructed of extruded aluminum (minimum 0.080 inches) of nominal sizes shown on the drawings. The final sizes shall be coordinated with the size of selected associated equipment (such as propeller fans).
 - 2. Louvers shall be flanged stationary type. Depth to be 4 inches. Blades to be approximately 37 degrees providing a vision proof design. Provide with rain hook plus 5/8-inch lip at front and back.
 - 3. All screws to be stainless steel.
 - 4. Provided all louvers with bird screens of PVC coated galvanized steel or stainless-steel wire mesh. Mesh spacing shall be approximately 1.2 inch.
 - 5. Provide drip edge flashing for all louvers. Louvers shall be finished with a Kynar 500 color, as selected by the Engineer. Provide color selection chart.
 - 6. Manufacturer: Louvers to be Ruskin, Carnes, or approved equal.
 - 7. All finishes shall be approved by architect prior to procurement of product.

PART 3 EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DIFFUSERS, REGISTERS, AND GRILLES

- A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to ensure that products serve intended functions.
- B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.

- C. Securely fasten with edge gaskets all surface mounted flange type diffusers, registers and grilles to ductwork or ceilings. Draw air devices tight to finished surface to prevent leakage and smudging.
- D. Carefully align, mate and snugly fit butted lengths of linear diffusers.

3.3 SPARE PARTS

- A. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

END OF SECTION

SECTION 237200 - ENERGY RECOVERY UNIT (DOAS-1)

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 23 Sections apply to this Section:
 - 1. "Basic Mechanical Requirements."
 - 2. "Basic Mechanical Materials and Methods."
 - 3. "Electrical Requirements for Mechanical Equipment"
 - 4. "Meters and Gauges"
 - 5. "Valves"
 - 6. "Supports and Anchors"
 - 7. "Vibration Isolation"
 - 8. "Mechanical Identification"
 - 9. "Mechanical Insulation"
 - 10. "Hydronic Piping"
 - 11. "Basic Piping Materials and Methods"
 - 12. Testing Adjusting and Balancing"
 - 13. "HVAC Commissioning"
 - 14. "Direct Digital Control Systems"
 - 15. "Mechanical Ductwork"
 - 16. "Ductwork Accessories"

1.2 SUMMARY

- A. Extent of energy recovery unit work required by this section is indicated on drawings and schedules, and by requirements of this section. If any conflict exists in the documents, then the most stringent requirement shall apply. The drawings are in a state of continuing development and the installation of the DOAS unit shall be performed using the most current issued drawings at the time of construction. The schedules, flow and control diagrams, and sequences of operations listed on the Design Development Phase drawings shall be used for the procurement and manufacturing of the DOAS unit.
- B. Types of energy recovery unit specified in this section include custom built energy recovery unit.
- C. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Other Division 23 sections for piping, specialties, ductwork, etc., required external to energy recovery unit for installation; not work of this section.

2. Division 26 sections for the following work; not work of this section.
 - a. Power supply wiring from power source to power connection on energy recovery unit. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
 - b. Interlock wiring between electrically-operated equipment unit; and between equipment and field-installed control devices.
 - c. Interlock wiring specified as factory-installed is work of this section.
3. Provide the following electrical work as work of this section, complying with requirements of Division 26 sections:
 - a. Control wiring between field-installed controls, indicating devices, and energy recovery unit control panels.
 - b. Control wiring specified as work of Division 23 for automatic temperature controls is work of that section.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.
- B. Submit product data which verifies compliance with ASHRAE 90.1, or provide certified performance ratings by a qualified independent testing laboratory.
- C. Certifications: Factory test reports, including test of casing insertion loss performance.
- D. Unit manufacturer shall provide a detailed control sequence covering all modes of operation.
- E. Manufacturer's control coordination confirmation: Prior to submission of equipment shop drawings, manufacturer shall provide a letter of confirmation to verify that control requirements have been coordinated with the ATC contractor.
- F. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- G. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- H. Maintenance Data: Submit maintenance data and parts list for each energy recovery unit, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

1.4 QUALITY CONTROL

A. Codes and Standards:

1. ASHRAE Compliance:
 - a. Provide capacity ratings for energy recovery devices in accordance with ASHRAE 84 "Methods of Testing Air-to-Air Heat Exchangers."
 - b. HVAC equipment shall meet the energy performance requirements of ASHRAE 90.1.
2. NRCA Compliance: Provide roof curbs for roof mounted equipment constructed in accordance with recommendations of NRCA.
3. ARI Compliance: Test and rate energy recovery units in accordance with ARI 1060 "Standard for Air-to-Air Heat Recovery Equipment."
4. NFPA Compliance: Construct and install energy recovery unit incorporating electrical equipment in accordance with NFPA 70 "National Electrical Code."
5. UL Labels: Provide energy recovery units ancillary electrical components which have been listed and labeled by UL.
6. Provide OSHA-approved fan drive guard where required.
7. Unit operation: Unit shall start and operate within scheduled tolerance of nameplate voltage.
8. Make fan selections to the right of the peak static pressure point and not on any flat portion of the fan curve

B. WARRANTY

1. Overall, two-year parts and labor warranty for the entire unit including compressors and heat exchangers to begin at unit Startup.
2. Compressors: Five-year parts only.
3. Gas Fired Heat Exchanger: Ten years' parts only.
4. All warranties start on the date of Unit Startup.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Handle energy recovery unit and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged unit or components; replace with new.
- B. Store energy recovery unit and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading energy recovery unit, and moving them to final location.

1.6 CONTROL SYSTEMS DESCRIPTION:

- A. Unit manufacturer shall provide complete operational controls for unit operation,

temperature control functions, and all required safety devices. Provide weatherproof enclosure on unit for the manufacturer's microprocessor-based controller. Controller shall be complete with display and keypad. Minimum display size shall be 6-inch by 6-inch.

- B. The manufacturer controls shall tie into the building's existing Siemens Building Management System, via ASHRAE 135 BACNET-A Data Communication Protocol and communicate all unit points to the BMS. The BMS shall provide certain sensor inputs and command signals to the manufacturer controller, see the sequence of operations on the drawings.
- C. The entire unit shall be factory run tested, including the controls. This shall include factory mimicking the BACNET inputs and commands that will be field provided from the Siemens BMS.

1.7 SPARE STOCK:

- A. UV-C Lamps: Provide one complete set of spare bulbs.
- B. Provide one spare set of all filters.

PART 2 PRODUCTS

2.1 CUSTOM BUILT ENERGY RECOVERY UNIT (DOAS-1)

- A. Manufacturers: Subject to compliance with requirements, provide belt of one of the following:
 - 1. Daikin (Basis of Design)
 - 2. Innovent
 - 3. Annexair
- B. General
 - 1. Provide as indicated, factory-assembled and tested energy recovery unit of capacity and characteristics as scheduled and defined in these specifications.
 - 2. Unit shall be designed, engineered and manufactured for outdoor rooftop installation on a roof curb. Unit shall be shipped in a single piece from the factory, after being assembled, piped, wired, tested and fully charged with R-410a and compressor oil and run tested. Unit shall be electronically controlled and are available for direct expansion mechanical cooling, with gas heating source. The unit shall incorporate all safety and operating controls and equipped with single or multiple scroll compressors with independent refrigeration circuits. Fully identified tags and stickers shall be available on the unit to indicate any cautions and aid in unit service. Unit shall be run tested at factory and all parameters shall be verified before shipment. Wiring diagrams for long lasting life shall be shipped with each

unit in-side a special pocket in the electrical panel door. A nameplate with full data shall be riveted on the unit near the electrical panel.

2.2 UNIT BASE

- A. Unit's base shall be fabricated from welded structural (minimum of G90) galvanized steel C-channels members ranging between 4-8 inch in height depending on unit size and length, on the perimeter with internal cross-member supporting beams along the whole base length and width fabricated from galvanized steel G90 14 gauge. A double coat of paint shall be applied to the whole base construction including all C-channels and supporting members. Unit base shall be of double wall construction made from G90 18-gauge galvanized steel. The outer skin -exposed to the curb- shall be made from G-90 galvanized steel. All base wall shall be coated with electrostatic polyester powder coat, oven baked, which can meet 3,000 hours salt spray according to ASTM B117 standard.

2.3 UNIT CONSTRUCTION

- A. Unit framework shall be constructed of bolted G-90 16-gauge galvanized steel. shall utilize a Double wall panel construction. As a minimum the panel outer wall shall Unit be made from G-90 22-gauge galvanized steel & inner wall made from G-90 22-gauge galvanized steel. Unit roof shall be made from G-90 20-gauge galvanized steel and has a crown shape for useful drainage & furnished with standing seems.
- B. All walls, doors, ceilings and floors shall be manufactured in minimum 1" (One inch) thick insulated panels using high-density injected foam insulation. The insulation shall comply with UL-1995 (UL 181 and 723), ASTM, NFPA-90 A and B and 255 and ASHRAE specifications standards. Insulation shall be 2-part injected foam, with each panel individually insulated, casketed and completely removable from framework. All unit outer and inner walls, filter frames, and coil frames shall be coated with electrostatic polyester powder coat, oven baked, which can meet 3,000 hours salt spray according to ASTM standard B117.
- C. Hinged access doors shall be furnished for fan section, filter section, control panel section, and heating vestibule. All access doors shall be of the double wall construction with outer wall made from minimum G-90 22-gauge galvanized steel; while, inner wall made from minimum G-90 22-gauge galvanized steel, and shall seal against a clip-on door profile rubber gasket to prevent air and water leakage.
- D. Access doors shall be hinged with painted steel hinges of same handles and latches quantity. All access doors shall be insulated with a minimum of 1-inch high-density injected foam insulation. The insulation shall comply with UL-1995 (UL 181 and 723), ASTM, NFPA-90 A and B and 255 and ASHRAE specifications standards.
- E. Unit roof curbs shall be insulated type galvanized steel with cant strip coordinated with the thickness of the roof insulation. Curb shall be a minimum of 12" high above the

finished surface of the roof for normal type, and 24" high above the finished roof for air plenum side discharge type.

- F. Unit shall be factory tested under UL standard 1995 and labeled with UL, ETL or CSA.

2.4 ACCESS DOORS

- A. Unit shall be supplied with galvanized steel, 22/22-gauge double wall, hinged doors. Access doors shall be flushed with the outside of the unit and shall have gaskets and handles. Access doors must be able to swing a full 180° open to allow complete and full access. Each door shall come with a 304 stainless steel locking device for security. Access panels using screws as a method of opening or closing shall not be acceptable.

2.5 UVC LIGHTS:

- A. Ultra-Violet C-Band Lights shall be provided for the complete cooling coil and condensate pan. UV Germicidal System shall kill bacteria, fungi, and mold growing on cooling coils and in drain pans. UV Germicidal System components shall be constructed to withstand typical HVAC environments and be ETL listed under UL Standard 1598. Lights shall be wired to a manual reset door interlock safety switch to shut off lights when access door is open. The minimal UV-C energy striking the coil fins shall not be less than 820 $\mu\text{w}/\text{cm}^2$ at the closest point and through placement, not less than 60% of that value at the farthest point. Equal amounts are to strike the drain pan, either directly or indirectly through reflection. Installation - emitters and fixtures shall be installed at right angles to the conforming lines of the coil fins, such that through incident angle reflection, UV-C energy bathes all surfaces of the coil and drain pan as well as all of the available line of sight airstream. Provide one complete set of spare bulbs.

2.6 AIRFLOW MONITORING STATIONS (AFMS)

- A. There shall be AFMS at the locations indicated on the drawings. Air flow monitors shall be Pitot-Tube technology type with high sensor density to achieve an accuracy of +/- 3% of readings to NIST traceable airflow standards for duct/plenum airflow condition, Paragon Multi-Trans or approved equal.

2.7 COMPRESSOR:

- A. shall be equipped with suction gas-cooled hermetic scroll compressors. The first stage Unit compressor shall be VFD driven, mounted on rubber-in-shear (RIS) vibration isolators and equipped with operating oil charge, crank case heater, inherent solid state motor protector, suction strainer and short cycling delay timer protection. The maximum operating compressor speed shall be 3,500 rpm. Digital Scroll compressors shall NOT be acceptable due to both noise and reliability issues.

2.8 REFRIGERATION CIRCUIT

- A. Unit shall have individual refrigeration circuits. Each independent refrigeration circuit shall be tested, dehydrated, and fully charged with R-410a refrigerant. Each refrigeration circuit will be equipped with filter drier, moisture indicator sight glass, liquid line solenoid valve, liquid line shut off valve, automatic reset low safety protection pressure switch, manual reset high safety protection pressure switch, thermostatic expansion valve and factory assembled vertical distributor. All refrigerant tubing and materials must be made from copper or brass; hoses of any kind shall not be acceptable under any circumstances. Manifoldd compressors shall not be acceptable under any circumstances. All refrigeration piping, evaporator and condensers coils, connectors shall be manufactured of copper ONLY.
- B. The inverter compressor shall have a separate oil pump and an oil separator for each compressor that routes oil back to the compressor instead of through the discharge line.
- C. Refrigerant circuit shall have a bypass valve between the suction and discharge refrigerant lines for low head pressure compressor starting and increased compressor reliability. When there is a call for mechanical cooling the bypass valve shall open to equalizing the suction and discharge pressures. When pressures are equalized the bypass valve shall close and the compressor shall be allowed to start.
- D. All suction lines are insulated with closed cell rubber insulation, which is then wrapped in industrial fabric and epoxy painted; while, lines extending inside DOAS-1 sections shall be insulated with closed cell rubber insulation. All exposed refrigerant lines in the condenser side shall be fully epoxy coated for additional protection. Charging ports are provided from the condenser exterior or at its perimeter

2.9 CONDENSER COIL

- A. Constructed from aluminum fins mechanically expanded into seamless copper tubes. Each fin shall have a formed self-spacing collar covering the copper tube completely. Tubes shall be seamless copper Headers shall be made from heavy wall type L copper pipes. Headers shall be individually sized for each coil to minimize refrigerant pressure drop. Coils casing shall be made from 18-gauge galvanized steel with end plate having a die-formed extruded tube holes for maximum tube protection and support. Intermediate tube supporting shall be provided as required for additional strength. All coils shall leak tested under water. The same unit manufacturer shall manufacture coils. All aluminum condenser coils and micro-channel condenser coils shall not be acceptable under any circumstances.

OPTION: Condenser side shall have a complete wire mesh all around its perimeter (in the open type condenser).

2.10 CONDENSER FAN AND MOTOR

- A. Condenser fans shall be of the direct driven type with axial (propeller) blade, up-ward discharge, statically and dynamically balanced, with composite material blades and heavy-duty wire guards made from steel with electrostatic polyester powder coat, oven baked, totally enclosed fan cooled (TEFC) with permanently lubricated bearing and three phase power supply. Motors shall be equipped with factory mounted external overload. Motors shall have a NEMA standard frame, a class F motor insulation, and a 6 poles motor with a maximum motor speed of 1,100 rpm. Condenser fans shall be ECM type.

2.11 SUPPLY FANS

- A. Direct Drive Plenum Fan SWSI fans shall be Class II and shall have airfoil blades and (L50) 200,000-hour life bearings at maximum RPM of the cataloged class. Fan shaft shall be turned, ground and polished solid steel rated at maximum RPM below critical speed. Fan wheel and sheaves shall be keyed to the shaft. Fan wheels shall be fabricated of heavy gauge steel Or Aluminum. Plug fan capacities and curves shall be based on tests of complete assemblies, including housings, in an AMCA 300 certified test facility. They should not be estimates or extrapolations from free standing fan data. Fan shall be rated in accordance with AMCA 210 for performance and AMCA 300 for sound. Backward Inclined or Backward Curved flat blades are not acceptable as a substitute for Backward Inclined airfoil blades. Submit individual fan selection with performance and sound information. Fan sizes shall be the minimum as listed in the schedule. Flexible connection between fan inlet and panel casing.
- B. Due to Sound requirements only the sound spec for the project is the maximum sound data by octave band and dB(A) that are acceptable and only the fan type listed above and the manufacturers below will be acceptable.

2.12 MOTORS:

- A. TYPE: Open Drip Proof (ODP)
VOLTS: 460-208/3/60 Phase
RPM: 1750
EFF: Premium
Motor sizes shall be as indicated on the schedule.

2.13 ENERGY RECOVERY ENTHALPY PLATE

- A. The fixed plate energy recovery core is equipped with a bypass damper on the outside air path. If the RTU has an economizer internal to it then the bypass damper will open when the unit enters the economizer operating state and close when the unit leaves the economizer operating state.

- B. When the outside air is below 32F (adjustable) the bypass damper will open for 5 minutes (adjustable) every 60-minute period (adjustable). Exhaust air continues to run though the core during this time to remove frost buildup.
- C. The ERV core shall transfer both sensible and latent energy between the incoming fresh air stream and the exhaust stale air stream.
- D. The ERV core shall be in either a cross-flow or counter cross-flow orientation and have no moving parts.
- E. The ERV core shall be certified by AHRI under its Standard 1060 for Energy Recovery Ventilators. Products not currently AHRI certified will not be accepted.
- F. The ERV core shall achieve the minimum effectiveness value as indicated in the schedule.
- G. The fresh air stream must have complete separation from the stale air stream to prevent cross contamination.
- H. The ERV core shall have Exhaust Air Transport Ratio of 0.5% as tested to AHRI 1060 (EATR) to prevent cross-over of gases, contaminants or odors.
- I. The ERV core's Outdoor Air Correction Factor (OACF) shall not exceed 1.0 as tested to AHRI 1060 (OACF) Standard.
- J. The ERV core shall not be degraded or promote the growth of mold and bacteria with a rating of zero in testing according to ISO846 A and C.
- K. The ERV core must be able to tolerate freezing temperatures of -22°F and not have an increase in EATR or decrease in performance after being frozen.
- L. The ERV core must be able to tolerate high temperatures of +60°C and not have an increase in EATR or decrease in performance at these elevated temperatures.
- M. The ERV core must be freeze tolerant tested to 40 freeze thaw cycles from -20 to 0 C to +20 C while maintaining the energy recovery effectiveness and EATR rating of 0.5%.
- N. The ERV core must be water washable to remove dust and contaminants.
- O. The ERV core must be flame proof and comply with UL 723 with a flame spread index that shall not be over 25 and a smoke index that shall not be over 50.
- P. The ERV cores should have particulate filters positioned before the incoming air streams.
- Q. Accepted manufacturer: CORE Energy Recovery Solutions or approved equal, subject to compliance with requirements

2.14 DX COIL (DX and Condenser)

- A. Primary Surface shall be round (3/8" OD), seamless copper tubing brazed into the intruded header tube holes, using copper brazing alloys. Tubes shall be staggered in the direction of airflow. Aluminum and Micro-Channel coils shall not be acceptable.
- B. Secondary Surface shall consist of rippled aluminum plate fins for higher capacity and structural strength. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Bare copper tube shall not be visible between fins and the fins shall have no openings punched in them to accumulate lint and dirt. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates.
- C. Tests—complete coil core shall be tested with high air pressure under warm water and guaranteed for 250 psig working pressures. Individual tube tests and core tests before installation of header is not considered satisfactory substitution for a complete coil hydrostatic test.
- D. Capacities shall be as indicated in the schedule.
 - 1. Fin Material – Aluminum
 - 2. Casing materials - Galvanized steel
 - 3. Connection Materials – Threaded
 - 4. Drain - Type: Double sloped stainless steel drain pan
 - 5. Optional Coil Coatings - Polyurethane

2.15 HOT GAS REHEAT

- A. Unit shall include separate hot gas reheat coil downstream of DX coil. Piping and bypass/control valve shall be included to allow use of reheat coil during a dehumidification cycle with ability to bypass hot gas as needed to hot gas reheat coil or condensing unit as needed. Controls shall be modulating.
- B. Hot gas reheat coil shall be a Micro Channel design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 20°F temperature rise at all operating conditions.
- C. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.
- D. Each coil shall be factory leak tested with high-pressure air under water.

2.16 HEAT PUMP HEATING

- A. The evaporator coil, condenser coil, compressors and refrigerant circuit shall be designed for heat pump operation. The refrigerant circuit shall contain a 4-way reversing valve for the heat pump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.
- B. The refrigerant system shall have a pump-down cycle.
- C. The unit shall have a natural gas furnace for hybrid heating. When the heat pump operation cannot maintain the discharge air temperature setpoint the natural gas furnace shall temper the airstream to the discharge air temperature setpoint.

2.17 FILTERS

- A. Factory fabricated filter sections shall be of the same construction and material as the unit.
- B. Extended surface pleated type pre-Filters 4” nominal thickness MERV 8 and MERV 13 filters. Filter shall have an average atmospheric dust spot efficiency range of 25-30% per ASHRAE standard 52.1 test methods. E filters shall be suitable for VAV systems with operating face velocity ranges to 500 FPM for 2” filters. E35 filters are to be UL 900 Class 2 listed.
- C. Media – High-loft, non-woven cotton/synthetic blend
- D. Media Support – Diamond-shaped expanded metal
- E. Pleat Design – Radial wedge type
- F. Frame – Moisture-resistant chipboard with perforated steel support grilles.
- G. Medi-Pack – Sealed to prevent air bypass and adaptable for use in side access housings

2.18 OUTDOOR/RETURN AIR SECTION

- A. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1” differential

pressure in according with testing defined in AMCA 500. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for “free” cooling. If outdoor air is suitable for “free” cooling, the outdoor air dampers shall modulate in response to the unit’s temperature control system.

- B. Economizer assembly Fault Detection and Diagnostics (FDD) shall be 90.1, IECC, and California Title 24 compliant. Microteach III controls shall display a warning, and write a warning to the BAS, if the economizer malfunctions in accordance with 90.1, IECC, and Title 24 specifications.
- C. Dampers shall be low leakage type, furnished and installed by the unit manufacturer. Damper performance data shall be in accordance with AMCA standard 500 and tested in an Actuators shall be furnished, mounted and wired by the control contractor in the field unless otherwise specified.
- D. Gas Fired Heating Section:
 - 1. Natural gas fired heating section with packaged controls that modulate the heater with a 10 to 1 turn-down. The heating module shall be a tubular design with in-shot gas burners.
 - 2. Heat exchangers shall have welded construction with stainless steel tubes.
 - 3. The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.
 - 4. Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.
 - 5. The factory-installed DDC unit control system shall control the gas heat module. Field installed heating modules shall require a field ETL certification. The manufacturer’s rooftop unit ETL certification shall cover the complete unit including the gas heating modules.
- E. Electrical Features
 - 1. Control and power panels include the Across the line (direct on line) starting for the compressors, condenser and units fan motors.
 - 2. Internal motor protector for compressors
 - 3. Potential Free terminal for remote ON/OFF connection
 - 4. Control voltage is 24 Volt for all components inside electrical panel, while crank case heater, liquid solenoid valve, compressor motor protector and capacity unloaders are 220 Volt (all these components are located outside electrical panel)

5. Single point power entry
6. Provide a 120V/ 15A convenience outlet

2.19 CONTROLS

- A. Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.
- B. The stand-alone DDC controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate standalone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.
- C. The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.
- D. All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.
- E. The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to ensure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.
- F. The keypad interface shall allow convenient navigation and access to all control functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:
 1. Return air temperature.
 2. Discharge air temperature.

3. Outdoor air temperature.
4. Space air temperature.
5. Outdoor enthalpy, high/low.
6. Compressor suction temperature and pressure
7. Compressor head pressure and temperature
8. Expansion valve position
9. Condenser fan speed
10. Inverter compressor speed
11. Dirty filter indication.
12. Airflow verification.
13. Cooling status.
14. Control temperature (Changeover).
15. VAV box output status.
16. Cooling status/capacity.
17. Unit status.
18. All time schedules.
19. Active alarms with time and date.
20. Previous alarms with time and date.
21. Optimal start
22. Supply fan and exhaust fan speed.
23. System operating hours.
 - a. Fan
 - b. Exhaust fan
 - c. Cooling
 - d. Individual compressor
 - e. Heating
 - f. Economizer
 - g. Tenant override

G. The user interaction with the keypad shall provide the following:

1. Controls mode
 - a. Off manual
 - b. Auto
 - c. Heat/Cool
 - d. Cool only
 - e. Heat only
 - f. Fan only
2. Occupancy mode
 - a. Auto
 - b. Occupied
 - c. Unoccupied
 - d. Tenant override
3. Unit operation changeover control
 - a. Return air temperature

- b. Space temperature
 - c. Network signal
4. Cooling and heating change-over temperature with dead band
5. Cooling discharge air temperature (DAT)
6. Supply reset options
 - a. Return air temperature
 - b. Outdoor air temperature
 - c. Space temperature
 - d. Airflow (VAV)
 - e. Network signal
 - f. External (0-10 vdc)
 - g. External (0-20 mA)
7. Temperature alarm limits
 - a. High supply air temperature
 - b. Low supply air temperature
 - c. High return air temperature
8. Lockout control for compressors.
9. Compressor interstage timers
10. Night setback and setup space temperature.
11. Building static pressure.
12. Economizer changeover
 - a. Enthalpy
 - b. Dry bulb temperature
13. Currently time and date
14. Tenant override time
15. Occupied/unoccupied time schedule
16. One event schedule
17. Holiday dates and duration
18. Adjustable set points
19. Service mode
 - a. Timers normal (all time delays normal)
 - b. Timers fast (all time delays 20 sec)
20. If the unit is to be programmed with a night setback or setup function, an optional space sensor shall be provided. Space sensors shall be available to support field selectable features. Sensor options shall include:
 - a. Zone sensor with tenant override switch
 - b. Zone sensor with tenant override switch plus heating and cooling set point adjustment. (Space Comfort Control systems only)
21. To increase the efficiency of the cooling system the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The

discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:

- a. Airflow
- b. Outside air temperature
- c. Space temperature
- d. Return air temperature
- e. External signal of 1-5 vdc
- f. External signal of 0-20 mA
- g. Network signal

PART 3 EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which energy recovery unit are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordinate installation with the automatic temperature controls subcontractor so that the system and each unit operate in accordance with schedules and sequence of operations.
- B. Factory test entire unit after assembly for capacity and vibration after the unit is fully assembled and prior to shipment. Notify the owner and engineer 5 weeks prior to testing of the date of the factory test to allow for an optional factory witness test.
- C. NOTE: A “factory run test” is not a sufficient substitute for a capacity test prior to shipment. A vibration test at the fan manufacturer is not an acceptable substitute for a final vibration test after assembly and prior to shipment.
- D. The manufacturer shall provide within the unit, a detailed pre-shipping inspection checklist completed at the factory. Provided also will be a pre-start checklist and commissioning record which must be completed and faxed back to the manufacturer within 30 days of start up to validate the factory warranty.

3.3 INSTALLATION

- A. Install energy recovery where indicated, in accordance with equipment manufacturer's written instructions unit, and with recognized industry practices to ensure that unit comply with requirements and serve intended purposes.
- B. Install unit' level and plumb, firmly anchored, in locations indicated and so as to maintain manufacturer's recommended clearances.

- C. Connections: Connect supply and return piping, drains, ducts, and electrical devices in accordance with drawings and manufacturer's instructions. Ground equipment.
- D. Test each drain pan and assure that installed slope is as specified and pan drains completely.
- E. Install filter provided with unit before energizing the unit supply fan. For unit so designed, remove side panel of filter holder to permit access to filter.
- F. If unit has been operating for more than 30 days prior to testing and balancing, remove filter and install new filters using the spare stock.
- G. Coordinate with air balancing and provide the proper drive for fan speed to obtain the airflow and static pressure indicated on the drawings.
- H. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 16 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.4 TESTING

- A. Upon completion of installation of energy recovery unit, and after air-side and water-side balancing has been completed, test unit to ascertain percent effectiveness of heat transfer device. Adjust unit for maximum effectiveness. Furnish test report and include report in each copy of maintenance manual.

END OF SECTION

SECTION 238126 - VARIABLE REFRIGERANT VOLUME AIR CONDITIONING

PART 1 - GENERAL

1.1 QUALITY CONTROL

- A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.
- B. All wiring shall be in accordance with the National Electric Code (NEC).
- C. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
- D. Any approved manufacturer shall be rated and certified in accordance with AHRI standard 1230 and meet minimum efficiencies as scheduled.
- E. The approved manufacturer shall have parts, equipment and materials stocked within 50 miles of installed location.
- F. The approved manufacturer shall have factory trained service technicians available and within 50 miles of installed location.
- G. Mechanical equipment for wind-born debris regions shall be designed in accordance with ASCE 7-2010 and installed to resist the wind pressures on the equipment and the supports.
- H. The condensing unit will be factory charged with R410A.

1.2 SYSTEM DESCRIPTION

- A. The variable capacity, heat recovery air conditioning system basis of design shall be a Daikin Variable Refrigerant Volume Series (heat or cool model) split system as specified. The system shall consist of multiple evaporators, REFNET™ joints and headers, a three-pipe refrigeration distribution system using PID control and Daikin VRV® condenser unit. The condenser shall be a direct expansion (DX), air-cooled heat pump, multi-zone air-conditioning system with variable speed inverter driven compressors using R-410A refrigerant. Each condensing unit shall use high efficiency, variable speed all “inverter” compressor(s) coupled with inverter fan motors to optimize part load performance. The system capacity and refrigerant temperatures shall be modulated automatically to set suction and condensing pressures while varying the refrigerant volume for the needs of the cooling or heating loads. The control will be automatic and customizable depending on load and weather conditions. Indoor units shall use PID to control superheat to deliver

a comfortable room temperature condition and optimize efficiency. The condensing unit shall have capability to connect an indoor evaporator capacity up to 200% of the condensing unit capacity. All zones are each capable of operating separately with individual temperature control. A dedicated hot gas pipe shall be required to ensure optimum heating operation performance. Two-pipe, heat recovery systems requiring separation of the gas and liquid refrigerant shall be furnished with auxiliary electric heating coils. Contractor is responsible for any change to electrical requirements.

- B. Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously or all of the indoor units associated with one branch cool/heat selector box. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, or a BACnet BMS interface.
- C. Branch selector (BS) boxes shall be located as shown on the drawing. The branch selector boxes shall contain the refrigerant control piping and electronics to facilitate communications between the BS box and main processor and between the BS box and indoor units. The BS box shall control the operational mode of the subordinate indoor units.

1.3 ADDITIONAL REQUIRED FEATURES

- A. Advanced Zoning – A single system shall provide for up to 64 zones.
- B. Autocharging – Each system shall have a refrigerant auto-charging function. If Autocharging is not available alternate manufacturer shall furnish refrigerant charge calculation for each system prior to startup.
- C. Defrost Heating – Each system shall maintain continuous heating during defrost operation. Systems not capable of doing simultaneous heating and defrost shall be provided with electric heaters for all indoor and shall also provide de-rated performance accounting for heat removed from the system at ambient conditions of 10/9. Cost of heat pump size upgrade, electrical upgrade, installation and control shall be responsibility of the contractor.
- D. Oil Return Heating – Each system shall maintain continuous heating during oil return operation. Reverse cycle (cooling mode) oil return during heating operation shall not be permitted due to the potential reduction in space temperature.
- E. Independent Control – Each indoor unit shall use a dedicated electronic expansion valve for independent control.
- F. VFD Inverter Control & Variable Refrigerant Temperature – Each condensing unit shall use high efficiency, variable speed all “inverter” compressor(s) coupled with inverter fan motors to optimize part load performance. The system capacity and refrigerant temperatures shall be modulated automatically to set suction and condensing pressures

while varying the refrigerant volume for the needs of the cooling or heating loads. The control will be automatic and customizable depending on load and weather conditions.

- G. Indoor units shall use PID to control superheat to deliver a comfortable room temperature condition and optimize efficiency. Indoor units shall control to within one degree F deadband.
- H. Connection Ratios – The condensing unit shall have the ability to connect an indoor unit evaporator capacity of down to 50% and up to 200% of the condensing unit capacity. Alternative manufacturers shall submit data confirming connection ratio is adequate for calculated diversity factor.
- I. Simple Wiring – Systems shall use 16/18 AWG, 2 wire, multi-stranded, non-shielded and non-polarized daisy chain control wiring.
- J. Advanced Diagnostics – Systems shall include a self-diagnostic, auto-check function to detect a malfunction and display the type and location.
- K. Each condensing unit shall incorporate contacts for electrical demand shedding.
- L. Each system shall be capable of integrating with open protocol BACnet building management systems.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. The unit shall be stored and handled according to the manufacturer's recommendations.

1.5 PHYSICAL CHARACTERISTICS

- A. General: The advanced multi-zone controller shall be made from plastic materials with a neutral color. Each control shall have a LCD (Liquid Crystal Display) that shows On/Off, setpoint, room temperature, mode of operation (Cool/Heat/Dry/Fan/Auto), louver position, and fan speed.

1.6 ELECTRICAL CHARACTERISTICS

- A. General: The advanced multi-zone controller will require 24 VAC to power the controller. The advanced multi-zone controller shall supply 16 volts DC to the communication bus on the F1F2 (out-out) terminal of the outdoor unit. The voltage may rise or fall in relation to the transmission packets that are sent and received.
- B. Wiring: The advanced multi-zone controller communication wiring shall be terminated in a daisy chain design at the outdoor unit, which is then daisy chained to branch selector (Heat Recovery system), then daisy chained to each indoor unit in the system and

terminating at the farthest indoor unit. The termination of the wiring shall be non-polar. The remote-control wiring shall run from the indoor unit control terminal block to the remote controller connected with that indoor unit.

- C. Wiring size: Wiring shall be non-shielded, 2-conductor sheathed vinyl cord or cable, and 18 AWG stranded copper wire.

1.7 VRV CONTROL NETWORK

- A. The VRV Controls Network is made up of local remote controllers, multi-zone controllers, advanced multi-zone controllers, and open protocol network devices that transmit information via the communication bus. The VRV Controls Network shall also have the ability to be accessed via a networked PC. The VRV Controls Network supports operation monitoring, scheduling, error e-mail distribution, general user software, tenant billing, maintenance support, and integration with Building Automation Systems (BAS) using open protocol via BACnet or Lonwork interfaces; all of which blend to provide the optimal control strategy for the best HVAC comfort solution.

1.8 QUALITY CONTROL

- A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.
- B. All wiring shall be in accordance with the National Electric Code (NEC).
- C. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
- D. Mechanical equipment for wind-born debris regions shall be designed in accordance with ASCE 7-2010 and installed to resist the wind pressures on the equipment and the supports.
- E. The condensing unit will be factory charged with R410A.

1.9 STANDARD LIMITED WARRANTY

- A. The manufacturer shall warranty to the customer who is the original owner and user of the Daikin AC products specified above (“Customer”) that under normal use and maintenance for comfort cooling and conditioning applications such products (the “Products”) will be free from defects in material or workmanship. This warranty applies to parts only and is limited in duration to ten (10) years from the earlier to occur of (a) the date of original installation, whether or not actual use begins on that date, or (b)

eighteen (18) months from the date of shipment. Customer must present proof of the original date of receipt and of installation of the Product in order to establish the effective date of this warranty. Otherwise, the effective date will be deemed to be the date of manufacture plus sixty (60) days. Repaired or replacement parts are warranted for the balance of the warranty period applicable to the original part following the date on which the repaired or replacement part is provided to the Customer.

- B. Warranty shall be by the equipment manufacturer.

1.10 INSTALLATION REQUIREMENTS

- A. The system must be installed by a factory trained contractor/dealer. The bidders shall be required to submit training certification proof with bid documents. The mechanical contractor's installation price shall be based on the systems installation requirements. The mechanical contractor bids with complete knowledge of the HVAC system requirements. Untrained contractors who wish to bid this project must contact the representative for the manufacturer shown on the drawings to arrange training prior to bid day.

1.11 OPERATING RANGE

- A. The operating range in cooling will be 23°F DB ~ 122°F DB.
- B. The operating range in heating will be -13°F WB – 60°F WB.
- C. Simultaneous cooling/heating operating range will be -13°F WB – 60°F WB.
- D. Cooling mode indoor room temperature range will be 57°F - 77°F WB.
- E. Heating mode indoor room temperature range will be 59°F - 80°F DB.

1.12 REFRIGERANT PIPING

- A. The system shall be capable of refrigerant piping up to 540 actual feet or 620 equivalent feet from the condensing unit to the furthest indoor unit, a total combined liquid line length of 3,280 feet of piping between the condensing and indoor units with 295 feet maximum vertical difference, without any oil traps. REFNET™ piping joints and headers shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance. T style joints shall not be acceptable as this will negatively impact proper refrigerant balance and flow for optimum system capacity and performance. Code compliant copper piping shall be acceptable. Refrigerant pipe insulation shall be no less than ¾ inch thick HVAC refrigerant pipe insulation rated for indoor or outdoor, based on location used.

1.13 DESIGN BASIS

- A. The HVAC equipment basis of design is Daikin AC. If the installing contractor would like to propose an alternate manufacturer in addition to the basis of design, please include the form in section 2.5, along with all requested accompanying documentation.

PART 2 - PRODUCTS

2.1 CONDENSING UNIT

- A. The condensing unit shall be factory assembled in the United States and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of inverter scroll compressors, motors, fans, condenser coil, electronic expansion valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receiver and suction accumulator.
- B. Liquid and suction lines must be individually insulated between the condensing and indoor units.
- C. The condensing unit can be wired and piped with access from the left, right, rear or bottom.
- D. The connection ratio of indoor units to condensing unit shall be permitted up to 200%.
- E. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
- F. The condensing unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
- G. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
- H. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.
- I. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation. Each system shall maintain continuous heating during oil return operation. Reverse cycle (cooling mode) oil return during heating operation shall not be permitted due to the potential reduction in space temperature. If alternative manufacturer's system is incapable of heating during oil return, electric heating coil shall be furnished. Contractor is responsible for any change to electrical requirements, due to additional electrical requirements of electric heating coil.

- J. The condensing unit shall be capable of heating operation at -13°F dry bulb ambient temperature without additional low ambient controls or an auxiliary heat source.
- K. The system shall continue to provide Heat during Defrost to the indoor units while in the defrost mode. Reverse cycle defrost during heating operation shall not be permitted due to the potential reduction in space temperature. If alternative manufacturer’s system is incapable of Heating during Defrost, optional electric heating coil shall be furnished for all indoor units. Contractor is responsible for any change to electrical requirements, due to additional electrical requirements of electric heating coil.
- L. Unit Cabinet: The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
- M. Fan:
 - 1. The condensing unit shall consist of one or more propeller type, direct-drive 350 or 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
 - 2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
 - 3. The fan shall be a vertical discharge configuration with a nominal airflow maximum range of 5,544 CFM to 24,684 CFM dependent on model specified.
 - 4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
 - 5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
 - 6. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps as shown below.

Operation Sound (dB)	Night Mode Sound Pressure Level (dB)
Step 1 max.	55
Step 2 max.	50
Step 3 max.	45

- N. Condenser Coil:
 - 1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
 - 2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.

3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
4. The fins are to be covered with an anti-corrosion Ultra Gold coating as standard with a salt spray test rating of 1000 hours, acetic acid salt spray test of 500 hours. Manufacturers whose AHRI ratings do not reflect capacity reduction due to coatings shall be derated by 5%.
5. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.
6. The outdoor coil shall have three-circuit heat exchanger design eliminating the need for bottom plate heater. The lower part of the coil shall be used for inverter cooling and be on or off during heating operation enhancing the defrost operation.
7. The condensing unit shall be factory equipped with condenser coil guards on all sides.

O. Compressor:

1. The inverter scroll compressors shall be variable speed (PVM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency) shall be controlled to eliminate deviation from target value. Non-inverter driven compressors, which may cause starting motor current to exceed the nominal motor current (RLA) and require larger wire sizing, shall not be allowed.
2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “G-type” or “J-type.”
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be as low as 3% to 100%.
5. The compressors’ motors shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.
6. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
7. Oil separators shall be standard with the equipment together with an intelligent oil management system.
8. The compressor shall be spring mounted to avoid the transmission of vibration.
9. Units sized 6 tons shall contain a minimum of 1 compressor. 8–14-ton units shall contain a minimum of 2 compressors. 16-ton units shall contain a minimum of 3 compressors. 22–28-ton units shall contain a minimum of 4 compressors. 30–36-ton units shall contain a minimum of 6 compressors. In the event of compressor failure, the remaining compressors shall continue to operate and provide heating or

cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.

10. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours.

P. Electrical:

1. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded, stranded 2 conductor cable.
2. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one condensing unit with one 2-cable wire, thus simplifying the wiring installation.
3. The control wiring lengths shall be as shown below.

	Condenser to Indoor Unit	Condenser to Central Controller	Indoor Unit to Remote Control
Control Wiring Length	6,665 ft	3,330 ft	1,665 ft
Wire Type	16/18 AWG, 2 wire, non-polarity, non-shielded, stranded		

2.2 INDOOR VRV AIR HANDLING UNIT AND CONTROL

- A. General: Daikin indoor unit model FXZQ shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. It shall be a four-way air distribution type, white (RAL9010), impact resistant with a washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control BRC1E71 and BRC2A71. The indoor units sound pressure shall range from 29 dB(A) to 34 dB(A) at low speed measured at 5 feet below the unit.
- B. Performance: As Scheduled
- C. Indoor Unit:
 1. The Daikin indoor unit FXZQ shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm,

self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.
5. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.
6. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 21" of lift and has a built-in safety shutoff and alarm.
7. The indoor units shall be equipped with a return air thermistor.
8. All electrical components are reached through the decoration panel, which reduces the required side service access.
9. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
10. The voltage range will be 253 volts maximum and 187 volts minimum.

D. Unit Cabinet:

1. The cabinet shall be space saving and shall be located into the ceiling.
2. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
3. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
4. Fresh air intake shall be possible by way of direct duct installation to the side of the indoor unit cabinet.
5. A branch duct knockout shall exist for branch ducting supply air.
6. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Fan:

1. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP.
3. The airflow rate shall be available in high and low settings.
4. The fan motor shall be thermally protected.

F. Filter: The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

G. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.

2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 17 FPI design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1 -1/32 inch outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with a 21-inch lift shall be located below the coil in the condensate pan with a built-in safety alarm.
7. A thermistor will be located on the liquid and gas line.

H. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

I. Control:

1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.
3. The unit shall be compatible with a Daikin intelligent Touch advanced multi-zone controller or an intelligent Manager III customizable BMS. Consult with Daikin prior to applying controls.

J. Optional Accessories Available:

1. Direct fresh air intake kit (KDDQ44X60).
2. Supply air duct connections.
3. Remote "in-room" sensor kit (KRCS01-1B).
4. The Daikin wall mounted, hard wired remote sensor kit is recommended for ceiling-embedded type fan coils, which often result in a difference between set temperature and actual temperature. The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).

2.3 FXSQ – LOW HEIGHT CONCEALED CEILING DUCTED UNIT (Med. Static)

- A. General:** Daikin indoor unit FXSQ shall be a built-in ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, direct-drive DC (ECM) type fan with auto CFM adjustment at commissioning, for installation into the ceiling cavity. It is constructed of a galvanized steel casing. It shall be available

in capacities from 5,800 Btu/h to 54,000 Btu/h. It shall be a horizontal discharge air with horizontal return air configuration. All models feature a low height cabinet making them applicable to ceiling pockets that tend to be shallow. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control BRC1E71 and BRC2A71. Included as standard equipment, a condensate drain pan and drain pump kit that pumps to 25-5/16" from the drain pipe opening. The indoor units sound pressure shall range from 33 dB(A) to 43 dB(A) at low speed measured 5 feet below the ducted unit.

B. Performance: Each unit's performance is based on nominal operating conditions:

Cooling (Indoor 80°F DB / 67°F WB, Outdoor 95°F DB, 25 ft pipe length)	Heating (Indoor 47°F DB / 43°F WB, Outdoor 70°F DB, 25 ft pipe length)
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C. Indoor Unit:

1. The Daikin indoor unit FXSQ shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall be equipment with automatically adjusting external static pressure logic that is selectable during commissioning. This adjusts the airflow based on the installed external static pressure.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 18-3/8" of lift from the center of the drain outlet and has a built-in safety shutoff and alarm.
5. The indoor units shall be equipped with a return air thermistor.
6. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
7. The voltage range will be 253 volts maximum and 187 volts minimum.

D. Unit Cabinet:

1. The cabinet shall be located into the ceiling and ducted to the supply and return openings.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
3. The unit shall ship from the factory in a rear-return configuration, and shall be field-convertible to a bottom-return configuration.

E. Fan:

1. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
2. The unit shall be equipped with automatically adjusting external static pressure logic selectable during commissioning.
3. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz.
4. The airflow rate shall be available in three settings.
5. The fan motor shall be thermally protected.
6. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.
7. Fan motor external static pressure range for nominal airflow:

Model Number	Fan ESP (in. WG)
FXSQ05TAVJU to FXSQ15TAVJU	0.60 – 0.12
FXSQ18TAVJU to FXSQ48TAVJU	0.60 – 0.20
FXSQ54TAVJU	0.54 – 0.20

F. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2 or 3 row cross fin copper evaporator coil with 18 fpi design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1-1/4" outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with an 18-3/8" lift shall be located below the coil in the condensate pan with a built-in safety alarm.
7. A thermistor will be located on the liquid and gas line.

G. Filter: Contractor shall provide a field-fabricated filter rack for 1-inch MERV 8 filters in the return ductwork with a face area matching or exceeding that of the FCU inlet.

H. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

- I. Control: The unit shall have local controls provided by Daikin and remote control provided by Riptide to perform input functions necessary to operate the system.

2.4 FXMQ_P - CONCEALED CEILING DUCTED UNIT (Med. Static)

- A. General: Daikin indoor unit FXMQ_P shall be a built-in ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, direct-drive DC (ECM) type fan with auto CFM adjustment at commissioning, for installation into the ceiling cavity. It is constructed of a galvanized steel casing. It shall be available in capacities from 7,500 Btu/h to 54,000 Btu/h. It shall be a horizontal discharge air with horizontal return air configuration. All models feature a low height cabinet making them applicable to ceiling pockets that tend to be shallow. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control BRC1E71 and BRC2A71. Included as standard equipment, a condensate drain pan and drain pump kit that pumps to 18-3/8" from the drain pipe opening. The indoor units sound pressure shall range from 29 dB(A) to 40 dB(A) at low speed measured 5 feet below the ducted unit.

- B. Performance: As Scheduled

- C. Indoor Unit:

1. The Daikin indoor unit FXMQ_P shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall be equipped with automatically adjusting external static pressure logic that is selectable during commissioning. This adjusts the airflow based on the installed external static pressure.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 18-3/8" of lift from the center of the drain outlet and has a built-in safety shutoff and alarm.
5. The indoor units shall be equipped with a return air thermistor.
6. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
7. The voltage range will be 253 volts maximum and 187 volts minimum.

- D. Unit Cabinet:

1. The cabinet shall be located into the ceiling and ducted to the supply and return openings.

2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Fan:

1. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
2. The unit shall be equipped with automatically adjusting external static pressure logic selectable during commissioning.
3. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range of 0.12 to 0.47 HP respectively.
4. The airflow rate shall be available in three settings.
5. The fan motor shall be thermally protected.
6. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.
7. Fan motor external static pressure range for nominal airflow:

2.5 BRANCH SELECTOR (BS) BOX FOR VRV HEAT RECOVERY SYSTEM

- A. General: The BS boxes are designed specifically for use with the manufacturer's VRV heat recovery system components.
1. These selector boxes shall be factory assembled, wired, and piped.
 2. These selector boxes must be run tested at the factory.
 3. These selector boxes must be mounted indoors.
 4. When simultaneously heating and cooling, the units in heating mode shall energize their subcooling electronic expansion valve.
- B. Unit Components: These units shall have a galvanized steel plate casing.
- C. The BS box shall consist of three electronic expansion valves (EEVs) that are serviceable and replaceable without opening the refrigeration system. If the manufacturer employs any solenoid valves in lieu of EEVs pressure-rated shutoff isolation valves shall be provided and installed by contractor upstream and downstream of the BS box to facilitate serviceability without opening the refrigeration system. In addition, additional sound attenuation measures must be taken and provided at no additional cost to owner to ensure sound requirement listed below is met.
- D. In multi-port units, each port shall have its own electronic expansion valves. If common expansion/solenoid valves are used, redundant valves must be provided.
- E. The cabinet shall contain a subcooling heat exchanger.
- F. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.

- G. Nominal sound pressure levels shall not exceed 44 dB (A) while operating and 48 dB (A) max. Any alternate units not meeting this sound requirement shall be provided with additional attenuation (with means of servicing branch selector box), to meet sound levels of this paragraph.
- H. Condensate Removal: The unit shall not require provisions for condensate removal. If a different vendor than Basis of Design is selected by the contractor, contractor shall be responsible for all additional engineering design costs and costs of addition condensate drain work.
- I. Electrical:
 - 1. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
 - 2. The unit shall be capable of operation within the limits of 187 volts to 255 volts.
 - 3. The minimum circuit amps (MCA) shall be 0.1 and the maximum overcurrent protection amps (MOP) shall be 15.
 - 4. The control voltage between the indoor and outdoor unit shall be 18VDC non-shielded, stranded 2 conductor cable.

2.6 ADVANCED MULTI-ZONE CONTROLLERS

- A. The Daikin AC VRV advanced multi-zone controllers are compatible with all VRV, SkyAir, and Daikin RA and FTXS indoor units with the use of the KRP928BB2S RA Adapter. The advanced multi-zone controller wiring consists of a non-polar two-wire connection to the outdoor unit. The advanced multi-zone controllers may be wall-mounted and can be adjusted to maintain the optimal operation of up to 64 connected indoor unit groups and 128 indoor units. Set temperatures can be adjusted in increments of 1°F. In the cases where a system or unit error may occur, the VRV controllers will display a two-digit error code and the unit address.

2.7 INTELLIGENT TOUCH MANAGER

- A. The Intelligent Touch Manager (version 1.02) shall provide control for all VRV, SkyAir, and Daikin RA and FTXS indoor units with the use of the KRP928BB2S RA Adapter. It shall be capable of controlling a maximum of 64 indoor unit groups and 128 indoor units connected to a maximum of 10 outdoor units. The intelligent Touch Manager shall support operations superseding that of the local remote controller, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring.
- B. The controller wiring shall consist of a non-polar two-wire connection to the indoor unit at terminals F1F2 (out-out) of the outdoor unit. The intelligent Touch Manager is wall mounted and can be adjusted to maintain the optimal operation of the connected indoor units.

- C. The intelligent Touch Manager can be used in conjunction with the BRC1E71 (Navigation Remote Controller), the BRC2A71 (Simplified Remote Controller), or the BRC4C82/7E83/7C812/7E818 (Wireless Remote Controller), BACnet, and Lonworks interfaces to control the same indoor unit groups. The remote controller shall require daisy chain wiring for grouping multiple indoor units (up to 16) together. Manual addressing is required of each remote controller group associated with the intelligent Touch Manager. DIII-NET address can be set for one (1) indoor unit or each indoor unit in the remote controller group. No more than 2 remote controllers can be placed in the same group.
- D. The intelligent Touch Manager shall be equipped with two RJ-45 Ethernet ports to support interconnection with a network PC via the Internet, Local Area Network (LAN), or connection with a non-networked PC after completed installation.
- E. Web access functions shall be available so that facility staff can securely log into each Intelligent Touch Manager via the PC's web browser to support monitoring, scheduling, error email, and general user functions. Additional optional software functions of Power Proportional Distribution tenant billing and Energy Navigator shall also be available. The optional software shall require advanced purchase and can only be activated upon receipt of a license activation key from Daikin AC.
- F. Mounting: The intelligent Touch Manager shall be mounted on the wall or into the mounting fixtures included with the intelligent Touch Manager.
- G. Display Features:
 - 1. The intelligent Touch Manager shall be approximately 11.42" x 9.57" x 1.97' in size with a backlit 10.4" LCD display.
 - 2. Display information shall be selectable from English, French, Italian, Korean, Dutch, Portuguese, Chinese, Japanese, German, or Spanish.
 - 3. Featured backlit LCD with auto off after 30 minutes (default) is adjustable between 1 to 60 minutes, or the choice of 3 different screen savers.
 - 4. Area and Group configuration
 - a. Area contains one or more Areas or Groups
 - b. A Group may be an indoor unit, Di, Dio point that has a DIII-NET address
 - 5. An Area is a tiered group where management points (indoor unit, digital input/output, and analog input groups) can be monitored and controlled by global settings. Up to 650 Areas can be created. Area hierarchy can have up to 10 tiered levels (ex. top level: 1st floor West, 2nd level: offices, hallways, 3rd level: Office 101, 102, and 103, etc.). Area configuration shall classify levels of monitoring and control for each management point
 - a. Areas and Groups may be assigned names (ex. Office 101, Lobby, North Hallway, etc.)

6. The Controller shall display On/Off, Operation Mode, Setpoint, Space Temperature, Louver Position, Fan Speed for each Area or Group.
7. The Controller shall display Date (mm/dd/yyyy, yyyy/mm/dd, or dd/mm/yyyy format selectable) and day of the week along with the time of day (12hr or 24hr display selectable).
8. The Controller shall adjust for daylight savings time (DST) automatically.
9. Display information shall be updated every 3 seconds to show the latest status of the indoor unit groups.
10. System status icons shall display On/Off (color coded), Malfunction/Error (color coded), Forced Stop, Setback, Filter, Maintenance, and Screen Lock.
11. The controller shall display the temperature setpoint in one-degree increments with a range of 60oF – 90oF, 1oF basis (16oC – 32oC, 0.1oC basis).
 - a. Display of temperature setpoint information shall be configurable for Fahrenheit or Celsius.
12. Display shall reflect room temperature -58oF – 248oF, 1oF basis (-50oC – 120oC, 0.1oC basis) range in one degree increment.
 - a. Display of room temperature information shall be configurable for Fahrenheit or Celsius
13. The Menu List shall be used to configure options and display information for each Area or Group.
14. Error status shall be displayed in the event of system abnormality/error with one of three color coded icons placed over the indoor unit icon or lower task bar.
 - a. System errors are generated when the intelligent Touch Manager system with other VRV controls systems combined or power proportional distribution calculation errors occur. The intelligent Touch Manager shall display the error with a red triangle placed on the lower task bar
 - b. Unit errors occurring within the VRV system shall be displayed with a yellow triangle placed over the indoor unit icon
 - c. Limit errors are based upon preconfigured analog input upper and lower limit settings and are generated when the limits have been met. When limit error is generated, a yellow triangle will be placed over the unit icon.
15. Communication errors between the intelligent Touch Manager and the indoor units shall be displayed with a blue triangle placed over the indoor unit icon
 - a. Error history shall be available for viewing for up to 500,000 errors/abnormality events.
16. Floor plan layout
 - a. Capable of displaying site floor plan as the background for visual navigation. Indoor unit, DIII-NET Di and Dio, and External Di, DO, and Ai icons with operational status can be placed on the floor layout
 - b. Up to 4 status points can be assigned to the indoor unit icon (room name, room temperature, setpoint, and mode. Digital input and output icons will display On/Off status. Analog input icons will display analog value up to 60

floor layout sections can be created. Basic Operation capable of controlling by Areas or Groups. Controller shall control the following group operations:

- 1) On/Off
- 2) Operation Mode (Cool, Heat, Fan, Dry, and Auto)
- 3) Setpoint for current mode in the occupied period
- 4) Controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating based upon the Area or Group configurations.
- 5) Relative Setup (Cooling) and Setback (Heating) setpoints in the unoccupied mode adjustable to 2 - 120F (1 - 70C).
- 6) The high and low relative setback setpoints.
- 7) Setup and Setback setpoints can be set inside or outside of the occupied setpoint range.
- 8) The recovery differential shall be 40F (default) and adjustable between 2 - 100F. Settings shall be applied based upon the Area or Group configurations.
- 9) Fan Speed: Up to 3 speeds (dependent upon indoor unit type)
- 10) Louver direction (dependent upon indoor unit type) 5 fixed positions or swing position
- 11) Remote controller permit/prohibit of On/Off, Mode, and Setpoint
- 12) Lock out setting for Intelligent Touch Manager display
- 13) Indoor unit Group/Area assignment

c. Capable of providing battery backup power for the clock at least 1 year when no AC power is applied.

- 1) The battery can last at least 13 years when AC power is applied
- 2) Settings stored in non-volatile memory
- 3) Programmability: Controller shall support weekly schedule settings.
- 4) 7-day weekly pattern
- 5) The schedule shall have the capabilities of being enabled or disabled
- 6) 100 independent schedules configurable with up to 20 events settable for each day's schedule.
- 7) Each scheduled event shall specify time and target Area or Group.
- 8) Each scheduled event shall include On/Off, Operation Mode, Occupied Setpoint, Pre-Cool, Pre-Heat, Setback High, Setback Low, Remote Controller On/Off Prohibit, Remote Controller Mode Prohibit, Remote Controller Setpoint Prohibit, Timer Extension Setting, Fan Speed, and Setpoint Range Limit. Setpoint when unit is On (occupied) Configurable Setup (Cooling) and Setback (Heating) setpoints when unit is Off (unoccupied). Time setting in 1-minute increments. Timer Extension shall be used for a timed override (settable from 30 - 180 minutes) to allow indoor unit operation during the unoccupied period.
- 9) A maximum of 40 exception days can be schedule on the yearly schedule (repeats yearly). Exception days shall be used to override specified days on the weekly schedule based upon irregular

occupied/unoccupied conditions. Exception days can be configured on a set date (Jan 1) or floating date (1st Monday in September)

- d. Controller shall support auto-changeover.
 - 1) Auto-change shall provide Fixed, Operating, and Averaging changeover methods for both Heat Pump and Heat Recovery systems based upon the changeover group configuration. This will allow for the optimal room temperature to be maintained by automatically switching the indoor unit's mode between Cool and Heat in accordance with the room temperature and setpoint. When selecting the Auto-changeover method the Differential should also be set (default value 4oF, adjustable between 0 – 13oF). The (Thermal) Differential is the tolerance for the indoor unit's setpoint. When the difference between the representative room temperature and the representative indoor unit setpoint exceed the thermal differential, the operation mode is changed. When the mode is changed from Cool to Heat the setpoint will be decreased by the thermal differential set in the Auto Changeover configuration (ex. If the mode is Cool with a 74oF setpoint and a changeover differential of 4oF, when switched from Cool to Heat the new setpoint for heating will be 70oF). When the mode is changed from Heat to Cool the setpoint will be increased by the thermal differential set in the Auto Changeover configuration (ex. If the mode is Heat with a 72oF setpoint and a changeover differential of 4oF, when switched from Heat to Cool the new setpoint for cooling will be 76oF).
- e. Fixed method
 - 1) Changeover evaluated by room temperature and setpoint of the representative indoor unit (first registered indoor unit in group) in the changeover group even when it is not operating (must be in Cool, Heat, or Auto mode)
- f. Operating method
 - 1) Changeover evaluated by searching for an indoor unit group that is operating in Cool, Heat, or Auto mode and uses the indoor unit room temperature and setpoint as the representative room temperature and setpoint. The order of the search is based upon the order each indoor unit group is assigned to the intelligent Touch Manager within the changeover group. If none of the indoor units in the group meet the above requirements the Fixed method of changeover will be applied.
- g. Average method
 - 1) Changeover evaluated by the average of all indoor unit group's room temperatures and setpoints operating in Cool, Heat, or Auto mode in the changeover group list.
 - 2) If none of the indoor units in the group meet the above requirements the Fixed method of changeover will be applied. If the average room

- temperature \leq average setpoint, the indoor units will be placed in Heat mode. If the average room temperature \geq average setpoint, the indoor units will be placed in Cool mode.
- 3) Changeover shall change the operation mode of the indoor unit that is set as the Changeover Master. The Changeover Master indoor unit shall then change the operation mode of all indoor unit groups daisy chained to the same outdoor unit in the Heat Pump system or branch selector box in the Heat Recovery system.
 - 4) Changeover from heat to cool mode shall occur when the room temperature is great than or equal to the heating setpoint, plus the setting of the thermal difference (0 – 13oF) with a safety allowance if necessary is established.
 - 5) Changeover from cool to heating mode shall occur when room temperature is less than or equal to the cooling setpoint, minus the setting of the thermal difference (0 – 13oF) with a safety allowance if necessary is established.
 - 6) 30-minute guard timer
 - a) Upon changeover, guard timer will prevent another changeover during this period. Guard timer is ignored by a change of setpoint manually from either intelligent Touch Manger or Remote Controller or by schedule.
 - 7) Controller shall support Interlock
 - a) Interlock feature for use with 3rd party equipment (DOAS, dampers, occupancy sensing, etc...) to automatically control Groups or Areas corresponding to the change of the operation states or the On/Off states of any Group.
 - b) WAGO I/O unit – Di, Do, Ai
 - (1) On/Off based monitoring and control of equipment
 - (2) Manual or scheduled operation of equipment
 - (3) Operation based upon interlock with VRV indoor unit groups
 - (4) Monitor equipment error/alarm status
 - 8) Digital Input/Output (DEC102A51-US2) unit or Digital Input (DEC101A51-US2) unit
 - a) On/Off based monitoring and control of equipment
 - b) Manual or scheduled operation of equipment
 - c) Operation based upon interlock with VRV indoor unit groups
 - d) Monitor equipment error/alarm status
 - e) Controller shall support force shutdown of associated indoor unit group
 - 9) Web/Email Function
 - a) Each intelligent Touch Manager shall be capable of monitoring, operating, and scheduling a maximum of 64 indoor unit groups (up to 512 indoor unit groups with the addition of the iTM Plus

Adapter) from a networked PC's web browser. It shall also be capable of creating general user access and sending detailed error emails to a customized distribution list (up to 10 email addresses).

- h. All PCs shall be field supplied
 - 1) Power Proportional Distribution (PPD) Software
 - 2) Provide a tenant billing option capable of calculating VRV Controls Network equipment energy usage in kWh based on the energy consumption of the outdoor units divided among the associated indoor units. This software is used in conjunction with the intelligent Touch Manager and a Watt Hour Meter (WHM). A maximum of 3-Watt Hour Meters can be connected to the intelligent Touch Manager. Up to 4 additional Watt Hour Meters can be connected to each iTM Plus Adapter, and up to 7 iTM Plus Adapters can be connected to the intelligent Touch Manager.
 - 3) g) The Power Proportional Distribution results data can be saved to a USB flash drive, or on a PC with the use of the web access. Data is saved in the CSV format. Results can be stored up to 13 months in the intelligent Touch Manager.

2.8 DCM601A72: iTM PLUS ADAPTER

- A. The iTM Plus Adapter shall provide control for all VRV, SkyAir indoor units, and Daikin RA and FTXS indoor units with the use of the KRP928BB2S RA Adapter. It shall be capable of handling a maximum of 64 indoor unit groups and 128 indoor units connected to a maximum of 10 outdoor units. The iTM Plus Adapter is to be used in conjunction with intelligent Touch Manager. Up to 7 iTM Plus Adapters can be connected to a single intelligent Touch Manager. This combination will provide intelligent Touch Manager monitoring and control of up to 512 indoor unit groups, 1024 indoor units, and 80 outdoor units. The iTM Plus Adapter shall support operations superseding that of the local remote controller, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring.
- B. The controller wiring shall consist of a non-polar two-wire connection to the outdoor unit at terminals F1F2 (out-out). The iTM Plus Adapter is wall mounted and is used in conjunction with the intelligent Touch Manager to maintain the optimal operation of the connected indoor unit(s). The iTM Plus Adapter is connected to the intelligent Touch Manager via a polarity sensitive 18-2 AWG stranded non-shielded wire (field supplied).
- C. The iTM Plus Adapter can be used in conjunction with the BRC1E71 (Navigation Remote Controller), the BRC2A71 (Simplified Remote Controller), or the BRC4C82/7E83/7C812/7E818 (Wireless Remote Controller), BACnet, and Lonworks interfaces to control the same indoor unit groups. No more than 2 remote controllers can be placed in the same group. The remote controller shall require daisy chain wiring for

grouping multiple indoor units (up to 16) together. Manual addressing is required of each indoor unit group associated with the iTM Plus Adapter.

- D. **Mounting:** The iTM Plus Adapter can be mounted on the wall or in a standard enclosure (field supplied).
- E. **Features:** The iTM Plus Adapter shall be approximately 6.30" x 5.87" x 2.41" in size.
- F. **Basic Operation:** Control of all associated indoor unit groups shall be done via the connected intelligent Touch Manager.
- G. **Programmability:** Programming of all associated indoor unit groups shall be done via the connected intelligent Touch Manager.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install units' level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- D. **Equipment Mounting:**
 - 1. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
 - 2. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration Controls for HVAC."
 - 3. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 4. Remove and replace malfunctioning units and retest as specified above.
 - 5. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service. Complete installation and startup check according to manufacturer's written instructions.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 238239 - UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.3 SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include details of anchorages and attachments to structure and to supported equipment.
 - 4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
 - 5. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Markels

- B. Berko Electric
- C. Modine
- D. Qmark

2.2 DESCRIPTION

- A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

- A. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.
- B. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.4 COIL

- A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection. Provide integral circuit breaker for overcurrent protection.

2.5 FAN AND MOTOR

- A. Fan: Aluminum propeller directly connected to motor.
- B. Motor: Permanently lubricate. Comply with requirements in Section 23" Common Motor Requirements for HVAC Equipment."

2.6 CONTROLS

- A. Controls: Unit-mounted thermostat or as indicated on drawings.
- B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

2.7 CAPACITIES AND CHARACTERISTICS

- A. Airflow: Reference schedule for detail.
- B. Electrical Characteristics for Single-Point Connection: Reference drawing schedule for detail.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall and ceiling unit heaters to comply with NFPA 90A.
- B. Install wall and ceiling unit heaters level and plumb.
- C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- D. Ground equipment according to Section 26 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 26 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION

SECTION 238316 - RADIANT-HEATING HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes radiant-heating piping, including:
 - 1. PEX pipe and fittings
 - 2. PEX-AL-PEX pipe and fittings
 - 3. Distribution manifolds
 - 4. Piping specialties
 - 5. Controls

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. PEX: Crosslinked polyethylene.
- C. PEX/AL/PEX: Crosslinked polyethylene/aluminum/crosslinked polyethylene.
- D. PTFE: Polytetrafluoroethylene plastic.

1.4 SUBMITTALS

- A. Product Data for each type of product. Include data for piping, fittings, manifolds, specialties, and controls; include pressure and temperature ratings, oxygen-barrier performance, fire-performance characteristics, and hot water-flow and pressure-drop characteristics.
- B. Shop Drawings: Show below grade piping layout and details drawn to scale, including valves, manifolds, below grade piping lay-out, controls, and support assemblies, and their attachments to building structure.
 - 1. Shop Drawing Scale: 1/4 inch = 1 foot.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which radiant-heating piping will be attached.
 - 2. Perimeter moldings.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For radiant-heating piping valves and equipment to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: Subject to compliance with requirements, provide products of one of the following:

- A. LoopCAD
- B. Watts
- C. Tekmar

2.2 PEX PIPE AND FITTINGS

- A. Pipe Material: PEX plastic according to ASTM F 876.
- B. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.
- C. Fittings: ASTM F 1807, metal insert and copper crimp rings, ASTM F 1960, cold expansion fittings and reinforcing rings.
- D. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.

2.3 PEX/AL/PEX PIPE AND FITTINGS

- A. Pipe Material: PEX plastic bonded to the inside and outside of a welded aluminum tube according to ASTM F 1281.
- B. Oxygen Barrier: Limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.

- C. Fittings: ASTM F 1974, metal insert fittings with split ring and compression nut (compression joint) or metal insert fittings with copper crimp rings (crimp joint).
- D. Flame-Spread and Smoke-Developed Indices: 25 and 50 or less, respectively, tested according to ASTM E 84.
- E. Pressure/Temperature Rating: Minimum 100 psig and 210 deg F.

2.4 EPDM PIPE AND FITTINGS

- A. Pipe Material: Crosslinked EPDM inner and outer tubes.
- B. Wall Thickness: Minimum 0.125 inch.
- C. Oxygen Barrier: Ductile aluminum foil layer applied to the inner tube to limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.
- D. Reinforcing Braid: Braided-aluminum wire between the inner and outer tube.
- E. Fittings: ASTM F 1807, copper with stainless-steel crimps or clamps.
- F. Pressure/Temperature Rating: Minimum 100 psig and 210 deg F.

2.5 DISTRIBUTION MANIFOLDS

- A. Manifold: Minimum NPS 1, copper or stainless steel.
- B. Main Shutoff Valves:
 - 1. Factory installed on supply and return connections.
 - 2. Two-piece body.
 - 3. Body: Brass or bronze.
 - 4. Ball: Chrome-plated bronze.
 - 5. Seals: PTFE.
 - 6. CWP Rating: 150 psig.
 - 7. Maximum Operating Temperature: 225 deg F.
- C. Manual Air Vents:
 - 1. Body: Bronze.
 - 2. Internal Parts: Nonferrous.
 - 3. Operator: Key furnished with valve, or screwdriver bit.
 - 4. Inlet Connection: NPS 1/2.
 - 5. Discharge Connection: NPS 1/8.
 - 6. CWP Rating: 150 psig.
 - 7. Maximum Operating Temperature: 225 deg F.

D. Balancing Valves:

1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
6. Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.
7. Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

E. Zone Control Valves:

1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Actuator: Replaceable electric motor.
6. CWP Rating: Minimum 125 psig.
7. Maximum Operating Temperature: 250 deg F.

F. Thermometers:

1. Mount on supply and return connections.
2. Case: Dry type, metal or plastic, 2-inch diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, connecting element and pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Black metal.
7. Window: Plastic.
8. Connector: Rigid, back type.
9. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem.
10. Accuracy: Plus, or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

G. Mounting Brackets: Copper, or plastic- or copper-clad steel, where in contact with manifold.

2.6 PIPING SPECIALTIES

A. Cable Ties:

1. Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
2. Minimum Width: 1/8 inch.
3. Tensile Strength: 20 lb. minimum.
4. Temperature Range: Minus 40 to plus 185 deg F.

B. Floor Mounting Staples:

1. Steel, with corrosion-resistant coating and smooth finish without sharp edges.
2. Minimum Thickness: 3/32 inch.
3. Width: Minimum, wider than tubing.

C. Floor Mounting Clamps:

1. Two bolts, steel, with corrosion-resistant coating and smooth finish without sharp edges.
2. Minimum Thickness: 3/32 inch.
3. Width: Minimum, wider than tubing.

D. Floor Mounting Tracks:

1. Aluminum or plastic channel track with smooth finish and no sharp edges.
2. Minimum Thickness: 1/16 inch.
3. Slot Width: Snap fit to hold tubing.
4. Slot Spacing: 2-inch, 3-inch intervals.

E. Heat-Emission Plates:

1. Formed aluminum suitable for radiant-heating piping.
2. Minimum Thickness: 1/16 inch.
3. Slot Width: Snap fit to maintain pressure fit on tubing.

2.7 CONTROLS

A. Sequence of operations are as specified in control drawings.

B. Provide snow melt control system with associated accessories, sensors (including outdoor temperature sensor and pavement and snow and ice sensor.)

C. Wall-Mounted Thermostat:

1. Manually operated with on-off switch.
2. Day and night setback and clock program with minimum four periods per day.
3. Operate pumps or open zone control valves if temperature falls below the thermostat setting, and stop pumps or close zone control valves when temperature rises above the thermostat setting.

D. Heated-Panel Thermostat:

1. Remote bulb unit with adjustable temperature range from 50 to 90 deg F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected pump or zone control valve.
3. Remote bulb on capillary tube, resistance temperature device, or thermistor for directly sensing radiant-panel temperature.
4. Stop pump or close zone control valves if heated-panel thermostat setting is exceeded.
5. Corrosion-resistant, waterproof control enclosure.

E. Precipitation and Temperature Sensor:

1. Automatic control with manual on, automatic, and standby/reset switch.
2. Precipitation and temperature sensors shall sense the surface conditions of outdoor and shall be programmed to operate pump and zone control valves as follows:
 - a. Temperature Span: 34 to 44 deg F
 - b. Adjustable Delay Off Span: 30 to 90 minutes.
 - c. Start Pump or Open Zone Control Valves: Following 2-minute delay if ambient temperature is below set point and precipitation is detected.
 - d. Stop Pump or Close Zone Control Valves: On detection of a dry surface plus time delay.
3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
4. Provide contactors to start pump and open valves.
5. Precipitation sensor shall be mounted in pavement.
6. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive radiant-heating piping for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 1. Ensure that surfaces and pipes in contact with radiant-heating piping are free of burrs and sharp protrusions.
 2. Ensure that surfaces and substrates are level and plumb.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Install the following types of radiant-heating piping for the applications described:

1. Piping in Exterior Pavement: EPDM, PEX or PEX/AL/PEX.
2. Piping in Interior Reinforced-Concrete Floors: EPDM, PEX or PEX/AL/PEX.

3.3 INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings or coordination drawings.
- B. Install radiant-heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.
- C. Connect radiant piping to manifold in a reverse-return arrangement.
- D. Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.
- E. Install manifolds in accessible locations, or install access panels to provide maintenance access as required in Section 083113 "Access Doors and Frames."
- F. Comply with requirements in Section 230510 "Hydronic Piping" and for pipes and connections to hydronic systems and for glycol-solution fill requirements.
- G. Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials according to Section 078413 "Penetration Firestopping."
- H. Piping in Level Fill Concrete Floors:
 1. Secure piping in concrete floors by attaching pipes to subfloor using tracks, clamps, or staples.
 2. Space tracks, clamps, or staples a maximum of 18 inches o.c. and at center of turns or bends.
 3. Maintain 3/4-inch minimum cover.
 4. Install a sleeve of 3/8-inch-thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
 5. Maintain minimum 40-psig pressure in piping during the concrete pour and continue for 24 hours during curing.
- I. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.
- J. After system balancing has been completed, mark balancing valves to permanently indicate final position.

- K. Perform the following adjustments before operating the system:
 - 1. Open valves to fully open position.
 - 2. Check operation of automatic valves.
 - 3. Set temperature controls so all zones call for full flow.
 - 4. Purge air from piping.

- L. After concrete or plaster heating panel has cured as recommended by concrete or plaster supplier, operate radiant-heating system as follows:
 - 1. Start system heating at a maximum of 10 deg F above the ambient radiant-panel temperature and increase 10 deg F each following day until design temperature is achieved.
 - 2. For freeze protection, operate at a minimum of 65 deg F supply hot water temperature.

3.4 FIELD QUALITY CONTROL

- A. Prepare radiant-heating piping for testing as follows:
 - 1. Open all isolation valves and close bypass valves.
 - 2. Open and verify operation of zone control valves.
 - 3. Flush with clean water and clean strainers.

- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Leak Test: After installation, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- C. Hot water radiant-heating piping will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports.

- E. Protect hydronic piping system from damage during construction.

END OF SECTION

SECTION 260010 BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Instructions to Bidders apply to this and the other sections of Division 26. The word drawings is inclusive of all drawings contained in the contract documents. Work pertaining to Division 26 may be contained in any drawing, any specification section, the General or the Supplementary Conditions. The presentation of requirements in separate specification sections, specification divisions, or individual drawing groupings (M, P, E, S, C, or A) is not intended to scope the work into separate subcontracts nor limit the work in any fashion. The contract documents work as a whole and the Contractor is required to provide all work (materials, equipment, and labor) as required to fully accomplish and make operational and complete all electrical work as reasonably inferable by any portion of the contract documents (drawings and specifications of all sections). In case of conflict in quantities of work indicated between any drawing or specification the contractor is to provide the greatest number and/or amount of work, including providing all supporting infrastructure reasonably inferable.

1.2 RULES AND REGULATIONS

- A. Work and materials shall conform to and be executed, inspected and tested in accordance with the latest edition of the National Electric Code and with the governing rules and regulations of federal and local governmental agencies.
- B. Other codes which will apply to this installation include the current editions of:
 - 1. ANSI C2 - National Electrical Safety Code
 - 2. NEMA Standards
 - 3. NFPA 101 - Life Safety Code
 - 4. Underwriters Laboratories
- C. Where governing codes indicate the Drawings and Specifications do not comply with the minimum requirements of applicable codes, be responsible for either notifying the Owner in writing during the bidding period of the revisions required meeting code requirements, or providing an installation which will comply with the code requirements.

1.3 SUMMARY

- A. This Section includes general administrative, material, and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:
1. Electrical, product general requirements and accesses.
 2. Submittals.
 3. Coordination drawings.
 4. Record documents.
 5. Maintenance manuals.
 6. Rough-ins.
 7. Electrical installations.
 8. Cutting and patching.
 9. Factory Training.
- B. Related Sections: The following sections contain requirements that relate to this section:
1. Division 23 Section "ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT," for factory-installed motors, controllers, accessories, and connections.
 2. Section 260050 - BASIC ELECTRICAL MATERIALS AND METHODS, for materials and methods common to the remainder of Division 26, plus general related specifications including:
 - a. Access to electrical installations.
 - b. Excavation for electrical installations within the building boundaries and from building to utility connections.
 3. Division 1 and 23 Section "Commissioning", for the commissioning process of all lighting control devices and systems.

1.4 SUBMITTALS

- A. Follow the procedures specified in Division 1 Section "Submittals."
- B. Submittal Register: Provide a submittal register for all Division 21 through 28 work, including but not limited to: product data, shop drawings, certified data, and quality assurance reports. The submittal register shall be submitted with the first Division 21 through 28 submittal packages sent to for engineer review. **NO SUBMITTALS WILL BE RETURNED UNTIL A COMPLETE SUBMITTAL REGISTER IS ISSUED.**
- C. Equipment and material submittals shall be grouped together to allow review of groups of items whenever possible. All equipment and preconstruction submittals, with the exception of coordination drawings and the Electrical Utility Company On-site drawings, shall be submitted in no more than four groups. Submittals may be issued electronically (except for the Operation and Maintenance Manuals); however, a minimum of one hard copy shall be issued directly to the Engineer for the Engineer's record. Hard copy

submittals shall be enclosed in hard back covers (preferably 3 ring binders) identifying the project and name and phone number of the individual responsible for the submittal. First page of each submittal section shall have a blank area to receive the Architects/Engineer shop drawing stamp in addition to the area for the General Contractor's approval stamp.

- D. The contractor is responsible for complying with all contract requirements. Checking of submittals by the architect or engineer is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action indicated by the architect or engineer is subject to the requirements of the contract documents. Should the architect or engineer miss catching an error or feature in the submittal that does not comply with the contract requirements the Contractor remains responsible for meeting the requirements of the contract. The contractor is responsible for: dimensions which shall be confirmed and correlated at the job site; confirming and correlating all quantities; fabrication processes and techniques of construction; coordination of work between all trades; and the satisfactory performance of his work.
- E. Shop Drawings and other Submittals from the Contractor are not Contract Documents and are not part of the Contract. The Contractor must not do any Work requiring Shop Drawings or other Submittals unless the Shop Drawings and Submittals have been approved in writing by the Engineer. Work that requires submittals shall not commence until complete compliance with submittal requirements have been met. Submittals are not considered complete until Contractor receives acceptable Architect/Engineer's written disposition on the submittal. All Work requiring approved Shop Drawings or other Submittals must be done in strict compliance with the Contract Documents. However, approval by the Engineer or the Owner is not evidence that Work installed pursuant to the Shop Drawings or Submittals conforms to the requirements of this Contract. The Owner and the Engineer have no duty to review partial Submittals or incomplete Submittals. The Contractor must maintain a Submittal log which must include, at a minimum, the date of each Submittal, the date of any resubmittal, the date of any approval or rejection, and the reason for any approval or rejection. The Contractor has the duty to carefully review, inspect, and examine any and all Submittals (particularly those initially prepared by vendors) before submitting them to the Owner or the Architect/Engineer.
- F. Submittals marked "No Exception Taken" indicate that the architect or engineer has found no obvious deviations from the contract requirements and that the contractor may continue the procurement process subject to compliance with the contract requirements.
- G. Submittals marked "Make Corrections Noted" indicate that the architect or engineer has made corrective notations on the submittal in response to contract deviations that he has found and that the contractor may continue the procurement process subject to compliance with the notations and the contract requirements.
- H. Submittals marked "Revise and Resubmit" indicate that the architect or engineer has found significant deviations from the contract requirements and that the contractor must correct the submittal in accordance with the architect or engineer's notations and resubmit

the submittal for review; however, the likelihood is that the submittal can be corrected to come into compliance with the contract requirements.

- I. Submittals marked “Rejected” indicate that the architect or engineer has found deviations from the contract requirements of such magnitude that the submitted cannot be made compliant with the contract requirements and will not be accepted for further consideration; that the contractor must prepare a new submittal using a different manufacturer, product, model, or process, as applicable, and in accordance with the contract requirements.
- J. Submittals marked “Submit Specified Item” indicate that the submittal is rejected and that only the item specified on the plans or in the specifications will be acceptable, and that the contractor must prepare a new submittal using the specified item.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.6 WARRANTIES

- A. All Division 26 equipment and devices shall be provided with a factory warranty for all parts and labor with 24-hour service. The warranty shall expire 24 months from the date of Substantial Completion, as defined by the date of the Substantial Completion Certificate. This is not necessarily a 24-month warranty period, rather, early start-up of the equipment prior to the substantial completion date should be expected and shall not affect the expiration date. The contractor shall coordinate this aspect with his suppliers as required.

1.7 EXTENDED WARRANTIES: Select pieces of equipment and devices may be specified to have extended warranties which expire after the primary project warranty lists in the paragraph above. However, extended warranties shall also be coordinated with the date of substantial completion to expire in time periods relative to the substantial completion certificate.

1.8 FACTORY START-UP: Provide factory start-up on major pieces of equipment. Startup of all electrical equipment shall be performed by a factory trained technician with at least 40 hours of factory training on said piece of equipment.

1.9 FACTORY TRAINING: Provide factory training on all equipment. Schedule training with at least 21 days’ notice to the owner and AE, by submitting a draft training schedule. Indicate all proposed training dates with specific equipment descriptions. The Contractor

shall then confirm these dates with the owner and AE, and after received approval of these dates shall submit a final training schedule at least 14 days prior to the agreed upon dates.

- 1.10 **CHANGES IN WORK:** When additional work is requested by the Owner or Engineer the Contractor shall provide a proposed change order to include a complete description of the additional work, a detailed breakdown of materials and labor removed by the change to be credited, and a detailed breakdown of materials and labor to be added. The value of credited work and additional work shall be priced on the same basis. Materials, labor, and any other cost shall be based upon the current version of the RS Means Mechanical Cost Data book, RS Means Plumbing Cost Data book, or RS Means Electrical Cost Data book. Actual supplier pricing for materials may be submitted so long as the pricing is competitive (within 5%) with competing local or internet-based sources and a detailed breakdown is provided. Manufacturer material shipping and handling costs may apply; however, normal contractor overhead costs, including the cost of supervision, shop drawing production, ordering, and internal transit costs may not be charged separately and shall be included in the overhead costs. Unless defined in other locations of these contract documents, the maximum allowable combination of overhead and profit for the general contractor and all subcontractors (of all tiers) shall not exceed 25% of the sum of the material and labor costs.
- 1.11 **USE OF THE TERM COORDINATE:** Whenever the term coordinate is used in any location of the drawings or specifications is shall be defined to mean to field confirm the actual item being provided and to modify, adjust, and provide all materials and work to make the item completely functional in the manner intended. This includes providing all work reasonably inferable.
- 1.12 **PRECEDENCE OF CONTRACT DOCUMENTS OVER REFERENCED STANDARDS.** No provision of a Referenced Standard is effective to change (i) the procedures established in the Contract Documents or by any applicable laws or regulations, or (ii) the duties and responsibilities of the Owner, Architect/Engineer or Contractor from those set forth in the Contract Documents; nor is any provision of a Referenced Standard effective to assign to the Owner or the Architect/Engineer any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility inconsistent with any other provision of the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Seconds, rejects, or damaged materials will be rejected.

- B. The equipment and devices to be provided under these Specifications shall be essentially the standard commercial grade product of the manufacturer. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer.
- C. The listing of a manufacturer for certain equipment and systems does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems shall conform to the Specifications.

2.2 U.L. LISTING

- A. All equipment shall bear the Underwriter's Laboratories (UL), or other approved agency, listing label.
- B. Wherein an item of equipment is specified to be U.L. Listed, the entire assembly shall be listed by Underwriters Laboratories, Inc. Any modifications to suit the intent of the Specifications shall be performed in accordance with the National Electrical Code and listed by U.L.

2.3 ACCESS

- A. Generally, all concealed junction boxes, control devices, duct mounted heat or smoke detectors and other items of equipment requiring maintenance and/or operation are located above accessible type ceilings. Should any concealed junction boxes, control devices, etc., be inaccessibly located, and furnish access doors with flush screwdriver operated lock, of size to permit complete access. Doors shall be of the type suited to the construction into which they are to be installed. Refer to Section 260050 - Basic Materials and Methods, for acceptable door requirements.
- B. Install electrical systems, materials, and equipment and coordinate with all adjacent items so as to maintain the manufacturer's recommended service clearance requirements. Indicate service clearance requirements on the coordination shop drawings. Advise the Engineer of any service clearance conflicts prior to installation. Remove, relocate, and revise conflicting items that have already been installed without additional cost to the Owner.
- C. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Minor deviations from the drawings may be made to allow for better accessibility at no additional cost to the Owner, but changes shall not be made without approval of the Engineer.
- D. Minimum clearances in front of or around equipment shall conform to the latest applicable code requirements.

PART 3 - EXECUTION

3.1 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 28 for rough-in requirements.

3.2 ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate electrical systems, equipment, and materials installation with other building components. Be responsible for any changes in openings and locations necessitated by the equipment installed.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - 5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - 7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
 - 8. Protect all equipment and materials from the elements, dirt and other damage from the time it is removed from the point of storage until final acceptance.
 - 9. Equipment shall include the component parts thereof such as disconnect switches, motor starters, motors, drives, and guards necessary to the satisfactory and safe operation of the equipment.
 - 10. Installation shall include setting equipment to accurate line and grade, leveling equipment, aligning equipment components, providing and installing couplings, bolts, guards, and anchor bolts.
 - 11. All tolerances in alignment and leveling, and the quality of workmanship for each class and stage of work shall be subject to manufacturer's installation instructions.
 - 12. All manufacturers' finished equipment surfaces damaged during construction shall be brought to an "as new" condition by touch up or repainting. Any rust shall be completely removed and the surface primed prior to repainting.
 - 13. Workmanship shall conform to the "Standard of Installation" published by the

National Electrical Contractors Association.

14. Division 26 shall do all trench and pipe excavation and backfilling required for his work inside and outside the building, including repairing of finished surfaces, all required shoring, bracing, pumping, and all protection for safety of persons and property. In addition, the Contractor shall check the indicated elevations of the utilities entering and leaving the building. If such elevations require excavations lower than the footing levels, the Architect shall be notified of such conditions and a redesign shall be made before excavations are commenced. It is also the responsibility of Division 26 to make the excavations at the minimum required depths in order not to undercut the footings.
15. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from the premises when no longer required.
16. No electrical equipment, raceways or other work of any kind shall be covered up or hidden from view before it has been examined and approved. Any unsatisfactory work or materials shall be removed and corrected immediately.
17. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
18. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
19. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "ACCESS DOORS" and Section 260050 - BASIC ELECTRICAL MATERIALS AND METHODS.
20. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.3 COORDINATION WITH LOCAL ELECTRICAL UTILITIES AND SERVICES

- A. Coordinate connection of electrical systems with exterior underground and overhead utilities and services and meet all of their schedules so that the electrical services proceed in a timely and orderly fashion. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- B. Locations and details required by Division 26 for the utility shall be the responsibility of Division 26.

3.4 MANUFACTURER'S DIRECTIONS AND SUPERVISION

- A. Where supervision by a manufacturer is specified, follow all instructions and recommendations of the manufacturer. The manufacturer shall supervise the installation, connection, start-up, and adjustment, instruction of the Owner and final tests of such equipment or system. Where two or more manufacturer's equipment are interrelated, take

responsibility to coordinate their work and provide supervision.

- B. Have the manufacturer instruct the Owner in the proper operation and maintenance techniques of all equipment, systems, etc., at the time of completion of all work.
- C. Prior to final acceptance by the Owner prepare and submit to the Architect for review 3 copies of operation and maintenance (O and M) instructions in printed form for each item of equipment or system installed in the building. Complete instructions for each system shall be assembled and bound in a brochure. Detailed contents of the O and M manuals are as hereinafter specified. Refer to appropriate Division 1 sections for general requirements affecting this work.

3.5 PAINTING

- A. Provide the prime painting of all equipment and materials furnished under Division 26 specifications, unless specifically stated otherwise. In general, all equipment except raceways and galvanized boxes that are not provided with a factory-applied final finish shall be delivered to the job site with a shop-applied prime coat of paint.

3.6 TEST AND INSPECTION

- A. Upon completion of the work, notify the Architect in writing, that the entire electrical installation has been examined, inspected, tested, calibrated or adjusted as specified and that it is ready for final inspection. Work to be connected prior to final inspection and also include all of the work specified for "Manufacturers' Directions and Supervision." Include specified testing and inspection of documentation.
- B. Prior to each inspection, provide a written certification that each system or piece of equipment to be operated during that test has been tested and does meet design performance criteria of the Contract Documents.
- C. On completion of the work, obtain Certificates of Compliance, and approval or acceptance from all authorities having jurisdiction over the work, and deliver these certificates to the Architect. The work shall not be deemed to have reached a state of completion until the certificates have been delivered.

3.7 LOOSE EQUIPMENT

- A. Provide four keys for every different piece of electrical equipment which is equipped with a lock.
- B. Provide all other loose equipment specified/supplied for use with all systems.

3.8 MARKERS

- A. Furnish and install punched color tape markers, or color-coded markers as determined by Owner. Affix to ceiling grid or to access panel to indicate which ceiling panel is to be removed to obtain access to what control device, duct mounted heat or smoke detector, etc.

3.9 SUBMITTALS AND SHOP DRAWINGS

- A. Refer to Division 1 for quantities and types of submittals and shop drawings.
- B. Submittals and shop drawings shall be submitted in groups by systems. For example, all lighting fixtures, lamps, ballasts and accessories shall be submitted simultaneously in one package.
- C. Where there are no specific submittal requirements in the specification section, provide manufacturer's standard literature showing the submittal items.
- D. Shop Drawings and/or Submittals Required:
 - 1. MC cable and associated connectors
 - 2. Automatic transfer switches
 - 3. Ballasts, LED Drivers and accessories
 - 4. Batteries and battery chargers
 - 5. Boxes
 - 6. Cable tray
 - 7. Central control and monitoring systems
 - 8. Circuit breakers
 - 9. Dimmers
 - 10. Disconnect switches
 - 11. Ductbanks and associated raceways
 - 12. Electrical devices
 - 13. Emergency generators and associated equipment
 - 14. Emergency generator control system
 - 15. Fire alarm systems
 - 16. Security and Access Control Systems
 - 17. Firestopping
 - 18. Fuses
 - 19. Grounding materials
 - 20. Intercom systems
 - 21. Interior and exterior lighting fixtures
 - 22. Lamps and LED Panels
 - 23. Lighting control equipment
 - 24. Low voltage wire and cable
 - 25. Motor starters
 - 26. Nameplates and device markings

27. Panelboards and cabinets for Communication/Special Systems
28. Protective devices
29. Public address/staff paging systems
30. Raceway connectors and fittings
31. Raceways
32. Site lighting
33. Systems cabinets
34. Switchboards
35. Transformers
36. Wiring devices

3.10 OPERATION AND MAINTENANCE MANUALS

- A. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include the following information for equipment items:
 - B. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - C. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - D. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - E. Servicing instructions and lubrication charts and schedules.
 - F. The minimum information that shall be furnished in the maintenance manual shall include the following:
 1. Individual characteristics for trouble shooting sequences for each item of each:
 - a. Branch circuit panel.
 - b. Communication system.
 - c. Distribution panel.
 - d. Dry-type transformers.
 - e. Emergency generator control system.
 - f. Fire alarm system.
 - g. Generator set.
 - h. Individual motor starter.
 - i. Special system.
 - j. Switchboard.
 - G. Catalog cut sheets for every item for which a shop drawing is required.

- H. Schedule of loads served from each:
1. Automatic transfer switch.
 2. Non-Automatic Transfer Switch
 3. Branch circuit panel
 4. Distribution panel.
 5. Emergency generator control system.
 6. Generator set.
 7. Switchboard.
- I. On-hand spare parts list and complete parts list for each:
1. Distribution panel.
 2. Emergency generator control system.
 3. Generator set.
 4. Individual motor starter.
 5. Special system.
 6. Switchboard.
- J. Tap setting schedule for each Transformer.
- K. Overload element schedule for each motor starter.
- L. Bolt tightening torques and inspection intervals on each:
1. Bolted bus connection.
 2. Cable connection.
 3. Miscellaneous bolted electrical connections.
- M. Manufacturers' recommended cleaning intervals and special procedures for each:
1. Cooling fins.
 2. Dry-type transformer coil assembly.
 3. Electrical equipment interior.
 4. Electrical equipment ventilation opening.
 5. Lighting fixture lenses and reflectors.
- N. Main and arcing contact adjustment and replacement for each:
1. Automatic transfer switch.
 2. Non-Automatic Transfer Switch
 3. Contactor.
 4. Circuit breaker.
 5. Fused switch.
 6. Motor starter.
- O. Calibration and exercise procedures and intervals for each:

1. Automatic transfer switch.
2. Non-Automatic Transfer Switch
3. Control system.
4. Generator set.
5. Insulated case breaker.
6. Molded case breaker.
7. Relay.

P. "As designed" and "as left" relay settings.

Q. Testing interval and target values for ground fault protection circuit relays.

R. Testing and troubleshooting procedures unique to special systems.

S. Approved special construction details that differ from the details shown on Drawings.

3.11 COORDINATION DRAWINGS

A. Quality Assurance:

1. Coordination Drawing Subcontractor: Employ the services of a third-party entity who is not providing any physical construction work and who specializes in coordination drawing preparation utilizing three-dimensional modeling techniques. The coordination drawing subcontractor shall have a minimum of five years of experience in providing this type of service using three-dimensional modeling. The coordination drawing subcontractor shall be directly contracted by the General Contractor.
2. Submittals: Within 30 days of receipt of notice to proceed submit the following. No other Division 21 through 28 submittals shall be released until after submission of this material.
3. Coordination Drawing Subcontractor Qualifications: Provide a firm profile describing the experience of the company in providing these services along with three project examples (including a name and phone number for a reference for each project). Provide a resume for key staff who will work on the project. Coordination Implementation Plan: Submit a narrative description of how the coordination drawing subcontractor will work with the general contractor and each trade subcontractor. The narrative shall explain how individual trade shop drawings will be developed in concert with the coordination drawings, how coordination between the trades shall be accomplished, and how coordination meetings will occur along with a schedule. Indicate how structural steel shop drawings will be developed to coordinate with actual equipment and system weights and openings, and how the structural steel and Division 21 through 28 shop drawings and the coordination drawings shall all coordinate. Discuss how existing and new building architectural elements shall be accurately modeled and coordinated. Discuss how site features, such as grades and site utilities shall be modeled and coordinated. Explain what software will be used for each of the

- individual trades to produce their shop drawings, what software shall be used for modeling of the coordination drawings, and what software shall be used for clash detection. Explain the proposed clash resolution process.
4. Shop Drawings: Submit color shop drawings along with the native electronic drawing file. Unless the native electronic file is AutoCAD, Revit, or Navisworks, submit two copies of the viewing software required for the Architect and Engineer to review the model in 3D, including panning, zooming, and rotating views.
 5. Coordination Drawing Activity Kick-off Meeting: Prior to the development of any trade shop drawings conduct a field meeting to kick-off the coordination process. Schedule the kick-off meeting with the architect and engineer a minimum of seven days in advance. The meeting shall review the complete coordination drawing process. Key staff and the foremen for every major trade shall be in attendance. Division 21 through 28 work shall not start on any portion of the site or building until Engineer's approval (or partial approval) of the associated coordination drawings for that portion of the work.
- B. Provide coordination drawings. Prepare coordination drawings in accordance with Division 1 Section "Project Coordination", to a scale of 1/4 inch = 1 foot - 0 inch or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Coordination drawings are a multi-discipline task and the drawings listed in both Division 21 through 28 shall be prepared by a single third party organization specializing in coordination drawing preparation and utilizing three dimensional modeling techniques to indicate: the building structure, walls, ceilings, lights, electrical and mechanical equipment, conduits 2" diameter and larger, ductbanks, cable trays, panelboards, switchgear, transformers, cabinets, racks, ductwork, HVAC piping, plumbing piping 2" diameter and larger, fire sprinkler piping, and similar features. Coordination drawings shall indicate both above ground and below grade work, both interior of the building and exterior of the building (on-site). Individual system shop drawings shall be prepared in coordination with the coordination drawing preparation. Coordination drawings shall indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the proposed locations of switchboards, panels, transformers, cable trays, racks, conduits, lighting fixtures, piping, ductwork, equipment, and materials. The contractor shall organize each subsystem to fit within the allowable space and shall propose minor to moderate alternative locations and/or rerouting of systems to resolve spatial conflicts. These adjustments shall be clouded. Include the items listed in the following paragraphs in the coordination drawing package.
- C. Indicate clearances to other equipment, systems, components, ductwork, piping, and structural elements.
 - D. Indicate clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
 - E. Show exterior wall and foundation penetrations.

- F. Show fire-rated wall and floor penetrations.
- G. Show equipment connections and support details.
- H. Indicate sizes and location of required concrete pads and bases.
- I. Detail the mechanical equipment rooms.
- J. Detail the electrical equipment rooms.
- K. Detail the IDF and MDF rooms.
- L. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
- M. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
- N. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communications systems components, sprinklers, and other ceiling-mounted devices.
- O. Prepare site utility drawings, coordinating the work with the Utility Company Structural Facilities shop drawing. Indicate all Division 21 through 28 work. Detail every crossing of Division 26 work with a site utility, including but not limited to: sanitary, storm, water, storm water retention, gas, geothermal, transmission lines, etc.
- P. Check for conflicts between Division 26 wall mounted devices and architectural furniture, fixtures, equipment, casework, and chalk/tack boards. Propose the relocation of Division 26 wall mounted devices and cloud the same on the drawings.

3.12 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, indicate installed conditions for:
 - B. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
 - C. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - D. Contract Modifications and actual equipment and materials installed.

3.13 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:
- B. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - 1. Uncover Work to provide for installation of ill-timed Work.
 - 2. Remove and replace defective Work.
 - 3. Remove and replace Work not conforming to requirements of the Contract Documents.
 - 4. Remove samples of installed Work as specified for testing.
 - 5. Install equipment and materials in existing structures.
 - 6. Upon written instructions from the Architect, uncover and restore Work to provide for Architect observation of concealed Work.
- C. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
- D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- F. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- G. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
 - 1. Refer to Division 1 Section "DEFINITIONS AND STANDARDS" for definition of experienced "Installer."

3.14 USE OF THE TERM COORDINATE: Whenever the term coordinate is used in any location of the drawings or specifications is shall be defined to mean to field confirm the actual item being provided and to modify, adjust, and provide all materials and work to make the item completely functional in the manner intended. This includes providing all work reasonably inferable.

3.15 FACTORY TRAINING: Provide factory training on all equipment. Schedule training with at least 21 days' notice to the owner and AE, by submitting a draft training schedule.

**MARYLAND STATE POLICE TACTICAL SERVICES
OPERATIONS & COMMAND BUILDING**

Project No: PA-75-210-001

Indicate all proposed training dates with specific equipment descriptions. The Contractor shall then confirm these dates with the owner and AE, and after received approval of these dates shall submit a final training schedule at least 14 days prior to the agreed upon dates.

END OF SECTION

SECTION 260050 BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements specified in Section 260010 - Basic Electrical Requirements apply to this Section.

1.2 SUMMARY

- A. This Section includes limited scope general construction materials and methods for application with electrical installations as follows:
 - 1. Excavation for underground utilities and services, including underground raceways, vaults, and equipment.
 - 2. Miscellaneous metals for support of electrical materials and equipment.
 - 3. Wood grounds, nailers, blocking, fasteners, and anchorage for support of electrical materials and equipment.
 - 4. Joint sealers for sealing around electrical materials and equipment; and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
 - 5. Access panels and doors in walls, ceilings, and floors for access to electrical materials and equipment.

1.3 DEFINITIONS

- A. The following definitions apply to excavation operations:
 - 1. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
 - 2. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
 - 3. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1

Specification Sections.

1. Product data for the following products:
 - a. Access panels and doors.
 - b. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for electrical materials and equipment.
 - c. Coordination drawings for access panel and door locations in accordance with Section 260010 - Basic Electrical Requirements.
 - d. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer for the installation and application of access panels, and doors.
- B. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
- C. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- D. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
- E. Provide UL Label on each fire-rated access door.

1.6 PROJECT CONDITIONS

- A. Conditions Affecting Excavations: The following project conditions apply:
 1. Maintain and protect existing building services which transit the area affected by selective demolition.
 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
 3. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.
- B. Existing Utilities: Locate existing underground utilities in excavation areas. If utilities

are indicated to remain, support and protect services during excavation operations.

- C. Remove existing underground utilities indicated to be removed.
 - 1. Uncharted or Incorrectly Charted Utilities: Contact utility owner immediately for instructions.
- D. Use of explosives is not permitted.
- E. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

- A. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.
- B. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve.
- C. Backfill and Fill Materials: Materials complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP; free of clay, rock, or gravel larger than 2 inches in any dimension; debris; waste; frozen materials; and vegetable and other deleterious matter.

2.2 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout, recommended for interior and exterior applications.
- F. Fasteners: Zinc-coated, type, grade, and class as required.

2.3 ACCESS DOORS

- A. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
- B. Frames: 16-gage steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - 1. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
 - 2. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - 3. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
- C. Flush Panel Doors: 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - 1. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism, 1-1/2 hr. "B" labeled.
- D. Locking Devices: Flush, screwdriver-operated cam locks.
- E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bar-Co., Inc.
 - 2. J.L. Industries.
 - 3. Karp Associates, Inc.
 - 4. Milcor Div. Inryco, Inc.
 - 5. Nystrom, Inc.

2.4 JOINT SEALERS

- A. General: All penetrations of building assemblies (walls, partitions, floors, slabs, etc..) shall be sealed closed around the penetrating item and the building element. The sealant shall generally be installed from both sides of the assembly when both sides are accessible during construction. In all applications sealants shall be installed in such a manner to resist the passage of smoke and sound.
- B. Fire Rated Assemblies: All penetrations of fire rated assemblies shall be sealed with a labeled fire safe material selected to maintain the specified fire rating of the assembly and installed in accordance with the manufacturer's installation instructions for the specific fire rating required. Provide all required components indicated in the manufacturer's installation instructions as required achieving the specified fire rating, including but not

limited to: sleeves, supports, flanges, and additional insulation as may be required.

- C. Fire-Resistant Joint Sealers: Refer to Division 7 Section "Through-Penetration Firestop Systems" for additional requirements for fire stopping to be furnished and installed by Division 26.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 EXCAVATION

- A. Slope sides of excavations to comply with local codes and ordinances. Shore and brace as required for stability of excavation.
- B. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
 - 1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
- C. Install sediment and erosion control measures in accordance with local codes and ordinances.
- D. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
 - 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
 - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.
- E. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
- F. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 deg F (1 deg 2 C).
- G. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 2. Under building slabs, use drainage fill materials.
 3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
 4. For raceways less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation of raceways, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
 5. Other areas use excavated or borrowed materials.
- H. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 2. Removal of concrete formwork.
 3. Removal of shoring and bracing, and backfilling of voids.
 4. Removal of trash and debris.
- I. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- J. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- K. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- L. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
 - a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.

M. Subsidence: Where subsidence occurs at electrical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.4 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

END OF SECTION

SECTION 260110 RACEWAYS

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes raceways for electrical wiring. Types of raceways in this section include the following:
1. Rigid galvanized steel conduit (RGS).
 2. Intermediate metal conduit (IMC).
 3. Electrical metallic tubing (EMT).
 4. Rigid nonmetallic conduit (RNC).
 5. Flexible metal conduit.
 6. Liquidtight flexible conduit.
 7. Conduit bodies.
 8. Conduit fittings.
 9. Surface raceways.
 10. Wireway and auxiliary gutters.
- B. Related Sections: The following Division 26 Sections contain requirements that relate to this Section:
1. Section 260533 - Cable Trays for cable-tray-type raceway.
 2. Section 260519 - Low Voltage Wires and Cables for other wiring methods.
 3. Section 260529 - Supporting Devices for raceway supports.
 4. Section 260533 - Boxes and Cabinets, for boxes used with conduit and tubing systems.
 5. Section 262726 - Wiring Devices for raceways with integral wiring devices.

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
1. Product Data for the following products:
 2. Conduit/Tubing fittings and connectors indicating use and UL listing for applications.
 3. Surface raceway and fittings.
 4. Wireway and fittings.
- B. Samples, 6 inches long of each type and size of surface raceway with required finish.
- C. Installation Instructions: Manufacturer's written installation instructions for wireway,

surface raceway, and nonmetallic raceway products.

1.3 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

1. National Fire Protection Association (NFPA):
 - a. No. 70, 1996 National Electrical Code, the following Articles:
 - b. 331, Electrical Nonmetallic Tubing.
 - c. 345, Intermediate Metal Conduit.
 - d. 346, Rigid Metal Conduit.
 - e. 347, Rigid Nonmetallic Conduit.
 - f. 348, Electrical Metallic Tubing.
 - g. 349, Flexible Metallic Tubing.
 - h. 350, Flexible Metal Conduit.
 - i. 351A, Liquidtight Flexible Metal Conduit.
 - j. 351B, Liquidtight Flexible Nonmetallic Conduit.
 - k. 352A, Surface Metal Raceways.
 - l. 352B, Surface Nonmetallic Raceways.
 - m. 362, Wiring.
2. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.

B. National Electrical Manufacturers Association (NEMA):

1. NEMA, RN 1, 1986 PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
2. NEMA, TC 3, 1982 PVC Fittings for Use with Rigid PVC Conduit and Tubing.
3. NEMA, TC 5, 1983 Corrugated Polyolefin Coilable Plastic Utilities Duct.
4. NEMA, TC 6, 1983 PVC and ABS Plastic Utilities Duct for Underground Installation.
5. NEMA, TC 7, 1983 Smooth-Wall Coilable Polyethylene Electrical Plastic Duct for Underground Applications.
6. NEMA, TC 8, 1983 Extra-Strength PVC Plastic Utilities Duct for Underground Installation.
7. NEMA, TC 9, 1983 Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.
8. NEMA, TC 10, 1983 PVC and ABS Plastic Communications Duct and Fittings for Underground Installation.

C. American National Standards Institute (ANSI):

1. ANSI-C80.2, 1983 Specification for Rigid Steel Conduit, Enameled.

2. ANSI-C80.3, 1983 Specification for Electrical Metallic Tubing, Zinc-coated.
3. ANSI-C80.5, 1983 Specification for Rigid Aluminum Conduit.
4. ANSI-C80.6, 1986 Intermediate Metal Conduit. (IMC)

D. American Society for Testing Materials (ASTM):

1. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL, or ETL
2. ASTM F 512-84 Standard Specification for Smooth Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation
3. UL 1, 1985 Flexible Metal Electrical Conduit.
4. UL 3, 1984 Flexible Nonmetallic Tubing for Electric Wiring.
5. UL 5, 1985 Surface Metal Electrical Raceways and Fittings.
6. UL 6, 1981 Rigid Metal Electrical Conduit.
7. UL 360, 1986 Liquidtight Flexible Steel Conduit, Electrical.
8. UL 514B, 1982 Fittings for Conduit and Outlet Boxes.
9. UL 651, 1981 Schedule 40 and 80 PVC Conduit.
10. UL 651A, 1981 Type EB and A Rigid PVC Conduit and HDPE Conduit.
11. UL 797, 1983 Electrical Metallic Tubing.
12. UL 870, 1985 Electrical Wireways, Auxiliary Gutters, and Associated Fittings.
13. UL 1242, 1983 Intermediate Metal Conduit.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Rigid Metallic Conduit:
2. Allied
3. LTV Steel
4. Steelduct
5. Triangle
6. Wheatland

B. PVC Coated Rigid Steel Conduit and Fittings:

1. Occidental Coating Company
2. Perma-Cote Industries
3. Rob-Roy
4. Wheatland

- C. Rigid Nonmetallic Conduit and Fittings:
 - 1. Canadian General Electric
 - 2. Carlon
 - 3. CertainTeed
 - 4. Condux
 - 5. National
 - 6. Olin

- D. Flexible Metal Conduit:
 - 1. American Flexible Conduit
 - 2. Carol
 - 3. Columbia Cable and Electric
 - 4. Ettco
 - 5. O-Z/Gedney

- E. Liquidtight Flexible Metal Conduit and Fittings
 - 1. American Flexible Conduit
 - 2. Anamet, Inc.
 - 3. Columbia Cable and Electric
 - 4. Ettco
 - 5. Flexible Technology Corp.
 - 6. Liquatite

- F. Conduit Bodies
 - 1. Appleton Electric Co.
 - 2. Carlon
 - 3. Crouse-Hinds Division, Cooper Industries, Inc.
 - 4. Killark Electric Mfg. Co.
 - 5. O-Z/Gedney
 - 6. Spring City Electrical Mfg. Co.

- G. Conduit Fittings
 - 1. Bridgeport Fittings, Incorporated
 - 2. ETP (Berger Industries, Inc.)
 - 3. Midwest Electric
 - 4. Neer
 - 5. O-Z/Gedney
 - 6. RACO
 - 7. Steel City
 - 8. Thomas and Betts

- H. Wireways and Auxiliary Gutters

1. Hoffman Engineering Co.
2. Keystone/Rees, Inc.
3. Lee Products Co.
4. Square D Co.
5. Walker-Parkersburg

2.2 METAL CONDUIT AND TUBING

- A. Intermediate Steel Conduit: UL 1242.
- B. Electrical Metallic Tubing and Fittings: ANSI C80.3.

2.3 NONMETALLIC CONDUIT AND DUCTS

- A. Rigid Nonmetallic Conduit: NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.
- B. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.
- C. Conduit and Duct Accessories: Types, sizes, and materials complying with manufacturer's published product information. Mate and match accessories with raceway.

2.4 CONDUIT BODIES

- A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with screw type connectors for EMT.
- C. Conduit Bodies 1 Inch and Smaller: Use bodies with screw type EMT connectors.

2.5 CONDUIT FITTINGS

- A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements.
- B. Rigid Galvanized Steel, Intermediate Steel and Rigid Aluminum Conduit: Use threaded type with bushed connections.
- C. Electrical Metallic Tubing Conduit: Use nylon insulated, concrete or raintight,

mechanical screw type connectors.

- D. Rigid Nonmetallic or Coated Conduit: Use fittings designed specifically for conduit type of same manufacturer.
- E. Flexible Metal Conduit: Use nylon insulated throats of the wedge and screw type.
- F. Liquidtight Flexible Conduit: Use threaded grounding cone with steel compression ring and tightening gland, steel body with insulated throat.
- G. Unlike Conduit: All junctions to be of same size and type conduit.
- H. Expansion and Deflection Fittings:
 - 1. Conduit movement in straight line direction.
 - 2. O-Z/Gedney type AX series.
 - 3. Up to 3/4 inch deflection and movement in all directions.
 - 4. O-Z/Gedney type DX series.
 - 5. Deflection and movement beyond 3/4 inch in all directions.
 - 6. O-Z/Gedney type AXDX series.
- I. Conduit Bushings
 - 1. Rigid Steel and Intermediate Steel Conduit: Threaded, grounded, insulating type with thermosetting or fiber insert in a metal body.
 - 2. Electrical Metallic Tubing Conduit: Identical to rigid steel or intermediate steel conduit bushing on electrical metallic tubing combination coupling.
- J. Conduit Seals
 - 1. Cast in place with pressure ring and sealing grommet.
 - 2. O-Z/Gedney type FSK series with FSKA membrane clamp adapter.
 - 3. Cast in place with two pairs of pressure rings and sealing grommets.
 - 4. O-Z/Gedney type WSK series.
 - 5. For sealing conduits installed in core-drilled, sleeved, or precast holes.
 - 6. O-Z/Gedney type CSM series with CSMC membrane clamp adapter.
 - 7. Thunderline Link-Seal series.

2.6 WIREWAYS AND AUXILIARY GUTTERS

- A. General: Electrical wireways and auxiliary gutters shall be generally NEMA 1 construction of types, sizes, and number of channels as indicated. Fittings and accessories including but not limited to couplings, connectors, tees, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match and mate with wireway as required for complete system. Provide corrosion resistant phosphate primer and baked gray epoxy

finish. Where features are not indicated, select to fulfill wiring requirements and comply with applicable provisions of NEC and NEMA standards.

PART 3 EXECUTION

3.1 CONDUIT RACEWAY APPLICATION

A. Rigid Galvanized Steel Conduit

1. May be used in:
 - a. Interior locations.
 - b. Direct contact with concrete.
2. Shall be used in:
 - a. Exposed exterior locations.
 - b. Hazardous locations.
 - c. Within seven foot area around boilers, incinerators and other heat producing equipment.
 - d. Exposed interior locations within seven feet of the floor for all power and signal conductors.

B. Intermediate Metal Conduit may be used in all applications noted for rigid galvanized steel conduit except hazardous locations.

C. Electrical Metal Tubing

1. May be used in:
 - a. Concealed interior locations above ceilings, in hollow studded partitions and in the cores of concrete masonry unit partitions.
 - b. Exposed interior locations above seven feet.
2. Shall be used in all exposed interior locations above seven feet for conductors of any type, except where MC cable is permitted.

D. (Schedule 40 and 80) Nonmetallic Conduit

1. May be used in:
 - a. Direct contact with earth.
 - b. Locations embedded in concrete.

E. Flexible Metal Conduit

1. May be used in:
 - a. Four to six feet long lengths for final connection to lighting fixtures.
 - b. Steel studwalls between outlets and from outlet to rigid raceway leaving wall.

2. Shall be used in:
 - a. 18 to 22 inch long lengths to form a slack "U" between rigid raceway system
 - b. Rotating equipment
 - c. Vibrating equipment
 - d. Equipment requiring adjustments in position
 - e. Transformers
- F. Liquid-tight Flexible Metal Conduit shall be used as specified for flexible metal conduit as follows:
1. Shall be used in:
 - a. Final connection to all kitchen equipment.
 - b. Damp locations.
 - c. Wet locations.
 - d. 18 to 22 inch long lengths to form a slack "U" between rigid raceway system and motors.

3.2 INSTALLATION

- A. General: Install electrical raceways in accordance with manufacturer's written installation instructions, applicable requirements of NEC, and as follows:
1. Minimum conduit raceway size shall be 3/4 inch except switch legs, which may be 1/2 inch.
 2. Provide supports for raceways as specified elsewhere in Division 26.
 3. Cut square, free of burrs due to field cutting or manufacture, and bush where necessary.
- B. Conduit Raceway Routing
1. Conceal in finished rooms except where exposure is clearly indicated. Provide stainless steel escutcheon plates for all finished wall, floor, and ceiling penetrations.
 2. Install raceways exposed in mechanical and electrical equipment rooms and electrical closets. Maintain a minimum 7 ft. head room.
 3. Install raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.
 4. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways.
 5. Route Raceways as required by job conditions unless dimensioned positions are shown on Drawings. Verify exact locations of all raceways, pull boxes, and junction boxes; resolve any conflicts before installation. Give priority in available

space to large steam mains, steam lines that pitch, waste lines, drain lines, large air ducts, and all structural steel, unless indicated otherwise.

6. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping.
7. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
8. Install with not more than three 90 degree bends or more than 100 feet of straight conduit between pull boxes. Provide and install all additional pull boxes to meet this requirement.
9. Minimum Spacing: 3 inches between raceways and cold water or waste piping, and 6 inches between raceways and parallel steam pipes, condensate pipes, hot water pipes and air ducts.
10. Do not place raceway less than one inch apart where they cross each other.
11. Install to provide adequate grounding between all outlets and the established electrical system ground.
12. Install to prevent water pockets.

C. Conduit Raceway Installation

1. Prevent foreign matter from entering raceways by using temporary closure protection
2. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
3. No raceways in above grade slab. Install in subgrade or in above grade in ceiling below

D. When installed embedded in concrete, or, in direct contact with the earth:

1. Provide rigid galvanized steel elbows for vertical rise through the concrete.
2. Provide rigid galvanized steel conduit for the first ten foot section when leaving a building.
3. Make watertight with asphaltum or other approved compound applied to conduit joints before assembled.
4. Join raceways with fittings and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.

E. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside the box.

F. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the

end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

- G. Complete installation of electrical raceways before starting installation of conductors within raceways.
- H. Install a grounding wire in all flexible metal conduits.
- I. Install pull wires in empty raceways. Use monofilament plastic line having not less than 200 lbs. tensile strength. Leave not less than 12 inches of slack at each end of the pull wire. Tag at each end identifying other end location.
- J. Telephone and Signal System Raceways 2-Inch Trade Size and Smaller: In addition to the above requirements, install raceways 2-inch and smaller trade size in maximum lengths at 150 feet and with a maximum of two, 90 deg bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.
- K. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid galvanized steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs with floor.
- L. If it is necessary to cut holes through webs of beams or girders, call such points to the attention of the Architect with size of hole before proceeding with work. All holes shall be cut no larger than absolutely necessary.
- M. Whenever conduit is installed on exposed steel columns, the conduit shall be installed on the column web, and not on the flange.
- N. All penetrations through existing floors shall be core drilled and sleeved.
- O. All conduit knockouts or holes on electrical apparatus which are not used shall be provided with new plugs to match the NEMA rating of the enclosure.
- P. Conduit Fittings:
 - 1. Run with couplings approved for the conduit being used. Running threads and chase nipples will not be accepted in runs of threaded conduit.
 - 2. Use mechanical compression type on one inch EMT conduit and smaller. Steel set screw acceptable.
- Q. Expansion-Deflection Fittings:
 - 1. Install in all raceways at the expansion joints of the building in such a manner that

the expansion joints of the building will function properly and not stress any electrical raceways. Movement will be required in all directions. Refer to "A" series Drawings for facility expansion joint locations.

2. Install on all straight conduit runs 1 inch trade size or larger in excess of 100 feet. Movement will be required in straight line direction only.
3. Maintain grounding continuity at each expansion-contraction fitting.

R. Conduit Seals:

1. Use type "FSK" cast-in-place where conduit passes through foundation walls less than 60 inches below finished grade.
2. Use type "WSK" cast-in place where conduit passes through foundation walls at 60 inches or more below finished grade.
3. Install watertight seals at all conduits passing through horizontal barriers. These seals may be types "FSK", "WSK", or "CSML". Sleeves shall extend at least two inches above the finished floor with 1/2 inch space around the conduit and this space sealed permanently watertight with a removable material (concrete not acceptable).
4. Install where conduits pass through barriers having a 30 degrees F or greater temperature differential in the spaces on either side at any time and in conduits entering or leaving supply and return air plenums. Install pliable removable plastic compounded the nearest box at the top end of vertical runs and at the hot end of horizontal runs.

S. Wireways and Auxiliary Gutters:

1. Support horizontally with expansion shields, concrete inserts or masonry shields, as required for wall where wireway is mounted. Provide supports at 5 foot centers.
2. Provide at least 42 inch clear in front of all wireways with front covers.

T. Multi-Outlet Assemblies: Support assemblies at 18 inch centers maximum, at each end, branch, and box. Provide blank cover sections at sinks and basins extending 6 feet on either side of basin. Make transition to other wiring method with proper fittings.

3.3 ADJUSTING AND CLEANING

A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris before installing or pulling conductors.

END OF SECTION

SECTION 260119 UNDERGROUND DUCTS AND MANHOLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Instructions to Bidders apply to this Section.
- B. Requirements of the following Divisions and Sections apply to this Section:
 - 1. Division 2 - Earthwork
 - 2. Division 2 - Site Drainage
 - 3. Division 3 - Concrete
 - 4. Division 7 - Waterproofing and Damp proofing of Manholes and Handholes
 - 5. Section 260010 - Basic Electrical Requirements
 - 6. Section 260050 - Basic Electrical Materials and Methods
 - 7. Section 260110 - Raceways
 - 8. Section 270526 - Grounding and Bonding

1.2 SUMMARY

- A. This section includes underground electrical work including the Duct Banks.

1.3 DEFINITIONS

- A. Duct: The general term for electrical conduit and other raceway, either metallic or nonmetallic, specified for use underground, embedded in earth or concrete.
- B. Duct Bank: A group of two or more ducts in a continuous run between two points.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
 - 1. Shop drawings shall show dimensions, reinforcing and construction details and shall include product data complete with catalog sheets, specifications and installation instructions.
 - 2. Submit shop drawings with the stamp or letter of approval from the serving electrical utility, when service entrance raceways apply, showing that all of their

requirements are met and connection will be made upon completion of the installation.

- B. Product data for metal accessories for manholes and handholes and raceway, duct, duct bank materials, and miscellaneous components. Include:
 - 1. Raceways and fittings.
 - 2. Raceway supports.
- C. Coordination drawings showing duct profiles and coordination with other utilities and underground structures.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

1.6 PROJECT CONDITIONS

- A. Subsurface conditions were investigated during the design of the project. Reports of these investigations are available for informational purposes only. Data in the reports are not intended as representations or warranties of accuracy regarding continuity of conditions (between soil borings or test kits). The Owner will assume no responsibility for interpretations or conclusions drawn from this material.
- B. Existing Utilities: Information on underground utilities and possible obstructions in the path of construction under this section was obtained through investigations during the design of the project. Reports of these investigations are available for informational purposes only. Data in the reports are not intended as representations or warranties of accuracy regarding conditions and locations. The Owner will assume no responsibility of interpretations or conclusions drawn from this information. The contractor shall verify the existing utilities, ductbanks/handhole/manhole locations and prior to any commencement of work and include this work in the bid.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the listed manufacturers for the project.

2.2 DUCTS AND FITTINGS

- A. General: Ducts and duct fittings and accessories for which listing has been obtained by one or more manufacturers shall be UL listed and labeled.
- B. Type: Underground duct bank raceways may utilize the following types of conduits, fittings, outlets, and seals in compliance with Section 260110 - Raceways:
 - 1. PVC Schedule 40.
 - 2. Rigid galvanized steel conduit.
- C. Special Requirements
 - 1. Fittings shall be suitable for a watertight installation. The following fittings are among those required:
 - a. Sweep elbows 4 foot minimum radius. Radius bends, long sweep type. Bend segments and/or 5 degree angle coupling.
 - b. Terminating vertical elbows at buildings and concrete pads shall be rigid galvanized steel. Terminating bushings shall be insulated grounding type. Provide corrosion protection (red lead or equal) for all cut and threaded ends.
 - c. Provide rigid galvanized steel conduit for the first ten foot section when leaving a building.
 - 2. Quantities and sizes as shown on Drawings.
 - 3. Watertight Seals
 - a. Conduits penetrating outer building walls. For conduits penetrating outer building walls, refer to "conduit seals" specified in Section 260111.
 - b. Underground concrete encased raceways penetrating outer building walls.
 - 1) For underground concrete encased raceways penetrating outer building walls, utilize duct seal.
 - 2) Approved Duct Seal Manufacturers:
 - a) Appleton Electric - DUC
 - b) Manville Corp. - Duxseal
 - c) OZ/Gedney – DUX
 - 4. Conduit Spacers and Levelers
 - a. Vertical lock style providing 3 inch vertical and horizontal separation with 3 inch base plate and holes for reinforcing bars.
 - b. Approved Manufacturers:
 - 1) Condux
 - 2) Underground Devices, Inc.
 - 5. Drag Line (Fishwire)
 - a. Minimum 1/8 inch wide polypropylene monofilament utility rope.
 - b. Approved Manufacturers/series
 - 1) American Synthetic Ropes - Flotorope
 - 2) Greenlee Tool Co. - 2 ply rope 431
 - 3) Ideal Industries - Pro-pull rope

4) Thomas Industries/Jet Line Products - Rope 232

2.3 CAST-IN-PLACE CONCRETE

- A. Conform to Division 3 Section "Concrete Work" for concrete and reinforcing.
- B. Aggregate for Duct Encasement: 3/8-inch maximum size.
- C. Strength: 3000 psi minimum 28-day compressive strength.

PART 3 EXECUTION

3.1 DEFINITION

- A. For Part 3 Execution, the words manhole, handhole and underground pullbox are synonymous.

3.2 PREPARATION

- A. Refer to Drawings for special construction and dimensional requirements.
- B. Provide all trenching, excavating, backfilling, and concrete required for underground duct bank raceway and manhole installations in accordance with Division 2 and Division 3. The exact location of each duct bank raceway and manhole shall be determined after careful consideration has been given to the location of other utilities, grading, and paving.
- C. Lay out the proposed course and obtain location approvals prior to installations.
- D. Obtain installation approval prior to concrete pour.

3.3 CORROSION PREVENTION

- A. Protect all metallic materials against corrosion. Exposed metallic parts of outdoor apparatus shall be given a rust-inhibiting treatment and standard finish by the manufacturer. Aluminum shall not be used in contact with the earth, and where connected to dissimilar metal shall be protected by approved fittings and treatment. All parts such as boxes, bodies, fittings, guards, and miscellaneous parts made of ferrous metals but not of corrosion-resistant steel, shall be zinc-coated in accordance with ASTM A123 or A153, except where other equivalent protective treatment is specifically approved. Steel conduits installed underground or under slabs on grade shall be coated with an approved asphaltic paint, plastic coating or shall be wrapped with a single layer of a pressure-sensitive plastic tape, half-lapped. Where pressure-sensitive plastic tape is used,

the conduit shall be coated with a primer recommended by the tape manufacturer before applying the tape.

3.4 UNDERGROUND DUCT BANK RACEWAY INSTALLATION

A. General

1. Raceway Handling: Keep raceways clean of concrete, dirt, or foreign substances during construction. Raceways shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Raceways shall be thoroughly cleaned before being laid. Plastic raceways shall be stored on a flat surface and protected from the direct rays of the sun.
2. Raceway Envelope: Raceways shall be reinforced and concrete encased for the following conditions:
 - a. Concrete Encased Raceways: Install concrete encased raceways more than 30 inches below finished surface unless otherwise indicated or directed.
 - b. Crossing Obstructions: Install rigid galvanized steel conduit where top of conduit system is less than 18 inches below finished grade when crossing obstructions (tunnels, steam lines, etc.).
3. Pitch raceways to drain into manholes and away from buildings and concrete pads sloping not less than 12 inches per 100 feet. Where no manhole exists in run, pitch toward building with closest and safest drain access. On runs between manholes where it is impossible to maintain the grade all one way, grade from center so that conduits pitch both directions toward manholes.

B. Footings

1. Concrete Encased Raceways
 - a. Provide footing bed Tamp and level grade, for pitch desired, the bottom of raceway trenches. Excavate an additional 3 inches where rock, soft spots and/or sharp edge materials are encountered, then fill and tamp level with the original bottom with sand or earth free from particles to approximate densities of surrounding firm soil to minimize conduit stress.
 - b. Provide a concrete footing not less than 3 inches thick and as wide as the encasement except in neatly excavated stable soils. Provide formwork as necessary. Install footings straight and true both in line of run and transversely. Finish with an even surface.
 - c. Incorporate anchoring devices into the footing for use in tying down raceway
 - d. Grade footings so that raceways maintain required pitch.
 - e. Reinforce footing ten feet beyond filled ground with No. 4 bars 4 inches on center parallel with raceway run.

C. Raceway Installation

1. General
 - a. Maintain and ensure full, even support of raceways throughout their entire length.
 - b. Raceway joints may be placed side by side horizontally but shall be staggered a minimum of 6 inches vertically.
 - c. Make raceway joints watertight.
 - d. Provide perimeter seals where raceways and encasements penetrate walls.
2. Concrete Encased Raceways
 - a. Tie down raceways to footing after raceways have been laid on footing with spaces and levelers (located no more than 8 feet apart).
 - b. Reinforce encasement with No. 4 bars 12 inches on center parallel with raceway run and No. 4 bar loops 18 inches on center perpendicular to raceway run within perimeter of encasement by 3 inches. Exception: Exterior lighting branch circuit raceways. And service entrances

D. Depth

1. Existing Grade to Remain: Install raceways more than 18 inches below the existing finished grade unless otherwise indicated or directed
2. Existing Grade Lower than Finished Grade: Install raceways more than 18 inches below the existing grade unless otherwise indicated or directed.
3. Existing Grade Higher than Finished Grade
 - a. Install raceways more than 18 inches below the finished grade unless otherwise indicated or directed.
 - b. Encase raceway with a rectangular or monolithic concrete cross-section providing formwork as necessary. Where connection is made to a previously poured encasement, the new encasement shall be doveled square to the existing encasement.
 - c. Provide a minimum of 6 inches of concrete cover around raceway bank perimeter and 3 inches between adjacent raceways.
 - 1) Exception: For parking lot and roadway lighting branch circuit. Avoid pouring a heavy mass of concrete directly on raceway. If unavoidable, protect with a plank. Direct the flow of concrete down the sides of the bank assembly to the bottom, compelling concrete to flow to the center of the bank and to rise up in the middle, thus filling all spaces uniformly. Ensure the absence of voids by working a long flat slicing bar or spatula liberally and carefully up and down between the vertical rows of raceways.
 - d. Allowance: Provide in bid all costs to provide an additional 30% length of run of duct bank to allow for field coordination, coordination with actual equipment termination point locations, and coordination with utility companies.

E. Backfilling

1. Provide a brightly colored corrosion resistant plastic warning tape about 12 inches below top of trench in backfill. The tape shall be suitably inscribed at not more than 10 feet on centers to permit easy identification and location of the raceway run.
2. Backfill shall be free from scrap material. Place backfill over raceways in tamped layers of 6 inches maximum each.

F. Cleaning Raceways

1. Prevent foreign matter from entering all raceways during installation.
2. After installation, clean raceways with tools designed for the purpose.
3. Report and demonstrate to the Owner's representative any defect found in the raceway systems that cannot be eliminated. Be responsible for any damage to cables resulting from imperfections in the raceways.

G. Capping Raceways

1. Spare Raceways
 - a. Seal the ends of new and/or existing spare conduits at concrete pad and within building. Seal with wood or plastic plugs or a contrasting color cement/sand mixture with wick for drainage.
 - b. Demonstrate to the Owner's representative that raceways installed for future use are clear of obstructions (draw mandrel one-half inch less than raceway). Install drag line in each raceway penetrating through seal and pigtailling minimum 2 feet. Provide wick for drainage.
2. Occupied Raceways: Seal the ends of raceways to be used for this contract until cables installed. After cable installation, seal raceways at slabs, building entrances, and first manhole outside building. Seal with seal duct leaving wick for drainage.
3. Spare Parking Lot and Roadway Raceways: Seal and cap raceway utilizing approved raceway cap fitting.

3.5 GROUND INSTALLATION

- A. Provide grounding materials per Section 270526 Grounding and Bonding.
- B. Bond all equipment frames, cable shield, cable racks, ground bus, conduit, and ground rods to the ground wire. Use fusion welds on ground rods, approved connectors on cable shields, and fusion welds elsewhere.
- C. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations.

END OF SECTION

SECTION 260120 LOW VOLTAGE WIRES AND CABLES (100-600 VOLTS)

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this section:
 - 1. Section 260010 Basic Electrical Requirements.
 - 2. Section 260050 Basic Electrical Materials and Methods.

1.2 SUMMARY

- A. This Section includes wires, cables, and connectors for power, lighting, signal, control and related systems rated 100 to 600 volts.
- B. Related Sections: The following Sections contain requirements that relate to this section:
 - 1. Division 2 Section "Earthwork" for trenching and backfilling for direct buried cable.
 - 2. Section 260035 - Boxes and Cabinets, for connectors for Terminating Cables in boxes and other electrical enclosures.

1.3 SUBMITTALS

- A. Product Data for electrical wires, cables and connectors.
- B. Provide local authority approval documentation for the application within shop drawing submissions for MC cables.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with provisions of the following code:
- B. NFPA 70 National Electrical Code.
 - 1. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.

- C. UL Compliance: Provide components which are listed and labeled by UL under the UL Std. 1569 Metal-Clad Cable.
- D. NEMA/ICEA Compliance: Provide components which comply with the WC-5 Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
- E. IEEE Compliance: Provide components which comply with Std. 82 Test procedures for Impulse Voltage Tests on Insulated Conductors.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Wire and Cable:
 - a. Alflex Corp.
 - b. American Flexible Conduit Co.
 - c. Cablec Corp.
 - d. Carol Cable Co. Inc.
 - e. Cerro Wire and Cable Corp.
 - f. General Cable Corp.
 - g. Pirell Cable Corp.
 - h. Pyrotanax USA Corp. (for type MI).
 - i. Rome Cable Corp.
 - j. Southwire Company.
 - k. Triangle PWC, Inc.
 - 2. Connectors for Wires and Cable Conductors:
 - a. AMP
 - b. Burndy Corporation
 - c. General Electric Co.
 - d. Gould, Inc.
 - e. Ideal Industries, Inc.
 - f. O-Z/Gedney Co.
 - g. Pyrotanax USA Corp. (for type MI).
 - h. Raychem Corporation
 - i. Square D Company
 - j. Thomas and Betts Corp.
 - k. 3M Company

2.2 WIRES AND CABLES

- A. General: Provide wire and cable suitable for the temperature, conditions and location where indicated.
- B. Conductors: Provide solid conductors for power and lighting circuits no. 10 AWG and smaller. Provide stranded conductors for sizes no. 8 AWG and larger.
- C. Conductor Material: copper for all wires and cables.
- D. Insulation: Provide insulation type in accordance with Part 3 below.
- E. Color Coding:

208/120 Volts		460/265 Volts	
Phase	Color	Phase	Color
A	Black	A	Brown
B	Red	B	Orange
C	Blue	C	Yellow
Neutral	White	Neutral	Gray
Ground	Green	Ground	Green

- F. Jackets: Factory-applied nylon or PVC external jacketed wires and cables for pulls in raceways over 100-feet in length, for pulls in raceways with more than three equivalent 90 deg. bends, for pulls in conduits underground or under slabs on grade, and where indicated.
- G. Cables: Provide the following type(s) of cables in NEC approved locations and applications where indicated. Provide cable UL listed for particular application:
 - 1. Metal-Clad Cable: Type MC.
 - 2. Underground Feeder and Branch-Circuit Cable: Type UF.
 - 3. Portable Cord: Type S.

2.3 CONNECTORS FOR CONDUCTORS

- A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

PART 3 EXECUTION

3.1 INSTALLATION OF WIRES AND CABLES

- A. General: Install electrical cables, wires and wiring connectors as indicated, in compliance

with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation", and in accordance with recognized industry practices.

- B. Coordinate wire/cable installation work including electrical raceway and equipment installation work, as necessary to properly interface installation of wires/cables with other work.
- C. Install #12 AWG minimum for circuits 100 volts and above.
- D. Increase conductor size as required due to availability. Minimum feeder conductor sizes are shown on Drawings. If increased, be responsible for associated feeder conduit size and increased ground conductor size per NEC.
- E. Ground and continuously polarize systems properly throughout following the color coding specified.
- F. Install UL Type UF cable with nonmetallic outer jacketing, for direct buried underground feeders.
- G. Install UL Type THHN or THWN wiring in conduit, for branch circuits #10 and smaller.
- H. Install UL Type XHHW or THHN wiring in conduit, for feeders and branch circuits #8 and larger.
- I. Install UL TYPE XHHW or THWN wiring in conduit, for feeders and branch circuits installed outside of the building envelope, in raceway in contact with soil, or whenever raceway may be subject to moisture and/or condensation.
- J. Pull conductors simultaneously where more than one is being installed in same raceway.
- K. Use of pulling compound or lubricant is to be avoided unless absolutely necessary; compound used must not deteriorate conductor or insulation and be one of the following:
 - 1. Ideal-Aqua-Gel
 - 2. Polywater
 - 3. Yellow 77
- L. Use pulling means including fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceway.
- M. Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible.
- N. Provide conductors of the same size from the protective device to the last load.
- O. Make conductor length identical for parallel feeders.

- P. Install wiring in conduits buried in plaster or in poured concrete after the encasing medium is set and dry and then only after conduits have been swabbed out.
- Q. Support conductor in vertical raceways. One cable support shall be provided at the top or as close to the top as practical, plus a support for each additional interval of spacing per table 300-19a of the NEC.
- R. Provide slack wire for all future connections with ends of wires taped and blank box covers installed.
- S. Do not bend cables, either permanently or temporarily during installation to radii less than that recommended by the manufacturer.
- T. Use conductors with 90 degree C insulation when wiring is within seven feet of passing over or attached to the following:
 - 1. Boilers and other heat producing equipment.
 - 2. Hot water heaters.
- U. Keep conductor splices to a minimum.
- V. Splices, Taps and Terminations
 - 1. Make splices and taps in wiring #10 AWG and smaller mechanically and electrically Secure with mechanical pressure type splicing devices as manufactured by 3M Company, Buchanan, Panduit, or approved equal.
 - 2. Make splices and taps of conductors #8 AWG or larger and all splices in more terminal boxes using compression connectors requiring the use of compression tools for securing the conductors in the connectors. Termination of conductors at all distribution equipment, except transformers, shall be made using mechanical lugs. Connectors shall be of high conductivity corrosion-resistant material and have actual contact area that shall provide at least the current carrying capacity of the wire or cable. For conductors #1/0 and larger, connector lugs shall be of the two-hole type. Connector lugs shall be bolted to bussing using Belleville washers in combination with flat washers and nuts. Compression connectors shall be as manufactured by Thomas and Betts, Burndy, or approved equal.
 - 3. Provide insulated connectors for splices and taps with a self-fusing rubber insulating tape that is non-corrosive to the connector and the conductor. Insulation tape shall have a minimum of 350 volts per mil dielectric strength. Friction or vinyl tape shall be applied directly over rubber insulating tape equal to 3M switch 88 type.
- W. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connector and terminals to comply with tightening

torques specified in UL Std. 486A and B.

3.2 EQUIPMENT CONNECTIONS

- A. Follow homerun circuit numbers shown on Drawings in connecting circuits to panelboards. In the event that field observation shows that the indicated circuit numbers are not connected to the corresponding panel overcurrent device, make all corrections necessary. Each branch circuit homerun containing two or more circuits with a common neutral shall be connected to the circuit breaker or switch in a three or four-wire branch circuit panelboard so that no two of the circuits will be fed from the same phase.
- B. Provide all wiring to and between motors, starters, line voltage (120-600 volt) control devices, disconnect switches and other related electrical equipment, except where such items are factory wired.
- C. Terminate power wiring for elevator systems at the respective controller, and be in compliance with the manufacturer's approved shop drawings.
- D. Provide power and all wiring connections to the control devices for electrically operated overhead doors, door operators and control devices which will be provided under another division.

3.3 METAL-CLAD CABLE (TYPE MC CABLE)

- A. May be used only when approved by the local authority having jurisdiction and only for concealed branch circuit wiring in spaces above ceilings and in hollow studded interior partitions starting twenty feet maximum from first wiring device off of a rigid metallic homerun raceway.
- B. In general, may be used only for lighting and convenience outlet wiring, and only for those branches and areas which are not identified herein as exceptions.
- C. The exception branches and areas where MC Cable is not acceptable for lighting and convenience outlet wiring are as follows:
 - 1. Computer rooms
 - 2. Emergency branch circuit
 - 3. Exposed locations
 - 4. Hazardous locations
 - 5. Kitchen equipment feeder and branch circuits
 - 6. Life safety branch circuits
 - 7. Mechanical, electrical, generator, battery and boiler rooms
 - 8. Sitework
 - 9. Wet and damp locations

- D. MC Cable shall be secured at intervals not exceeding 6 feet and within 12 inches of every outlet box or fitting.
- E. At all terminations, a fitting shall be provided to protect the conductors from abrasion. Approved insulating bushings shall be provided between the conductors and the armor. The connector or clamp by which the cable is fastened to boxes or cabinets shall be metal, of double lock-nut construction, UL approved for use with MC cable and of such design that the insulating bushing will be visible for inspection. Internal box cable clamps are not acceptable.

3.4 MAXIMUM BRANCH CIRCUIT LENGTHS

- A. The following indicates maximum installed length a circuit can have and still maintain an adequate voltage level at the last point of use. If the circuit length exceeds the length listed, used the next largest wire size. Multiple circuit runs in the same raceway shall have all conductors sized the same based on worst case circuit lengths. Double length is required for distance between 3 way switches.

Circuit Length (in feet)

Wire Size	2 Wire 1 Phase		3 Phase			
	120V.	277V.	208V	480V	208V	480V
12	90	150	60	150	75	170
10	80	150	70	155	80	180
8	80	175	65	150	75	170
6	95	200	80	180	90	200

3.5 WIRE AND CABLE MARKING

- A. Provide wire number labels (Brady or equal) at source, control, and device terminations corresponding to schematics or circuits used.

3.6 WIRING METHODS

- A. The following wiring methods shall not be used:
 - 1. Non-metallic sheathed cable.
 - 2. AC cable.
 - 3. Aluminum wire and cable.

3.7 ADDITIONAL CIRCUIT ALLOWANCE:

- A. Provide an allowance in the bid for twenty additional dedicated 120 volt circuits from any

panel board using 20 amp single pole breakers indicated as spare, and providing #10 hot, neutral, plus ground in 3/4" raceway terminating in a back box with GFCI receptacle and cover plate. Provide weatherproof cover if required. Allowance shall be from any position inside or outside (on the building) to the closest available panel board with spare breaker.

3.8 AS BUILT DRAWINGS

- A. Indicate all feeder sizes on the as-built drawings riser diagrams.

3.9 FIELD QUALITY CONTROL

- A. Prior to energization of circuitry, check installed wires and cables with megohm meter to determine insulation resistance levels to ensure requirements are fulfilled.
- B. Prior to energization, test wires and cables for electrical continuity and for short-circuits.
- C. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION

SECTION 260135 BOXES AND CABINETS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Instructions to Bidders and Division 1 Specifications Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this section:
 - 1. Section 260010 - Basic Electrical Requirements
 - 2. Section 260050 - Basic Electrical Materials and Methods
 - 3. Section 260110 - Raceways
 - 4. Section 270526 - Grounding and Bonding

1.2 SUMMARY

- A. This section includes cabinets, boxes and fittings for electrical installation and certain types of electrical fittings not covered in other sections. Types of products specified in this Section include:
 - 1. Steel Device Boxes
 - 2. Cast Device Boxes
 - 3. Floor Boxes
 - 4. Pull and Junction Boxes
 - 5. Cabinets
- B. Conduit-body type electrical enclosures and raceway fittings are specified in Section 260110 Raceways.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:
 - 1. Product data for cabinets and enclosures with classification higher than NEMA 1.
 - 2. Shop drawings for floor boxes and boxes, enclosures and cabinets that are to be shop fabricated, (nonstock items). For shop fabricated junction and pull boxes, show accurately scaled views and spatial relationships to adjacent equipment. Show box types, dimensions and finishes.

1.4 QUALITY ASSURANCE

- A. UL Listing and Labeling: Items provided under this section shall be listed and labeled by UL.
- B. National Electrical Code Compliance: Components and installation shall comply with NFPA 70 "National Electrical Code."
- C. NEMA Compliance: Comply with NEMA Standard 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)."

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - B. Steel Device Boxes
 - 1. Appleton Electric Co.
 - 2. Midland Ross Corp. (Steel City)
 - 3. Raco Inc.
 - C. Cast Device Boxes
 - 1. Appleton Electric Co.
 - 2. Crouse Hinds Electrical Construction Material
 - 3. Killark Electric Manufacturing Co.
 - 4. O-Z/Gedney
 - D. Floor Boxes
 - 1. Visible
 - a. Hubbell
 - b. Midland Ross (Steel City)
 - 2. Concealed
 - a. Raceway Components, Inc. Series RC560
 - b. Midland Ross 664 Series
 - E. Pull and Junction Boxes
 - 1. O-Z/Gedney
 - 2. Crouse Hinds

3. Appleton Electric Co.
4. Hoffman Engineering Co.
5. Lee Products
6. Hammond Manufacturing
7. Electromate Corporation

F. Cabinets

1. Galvanized Sheet Steel
 - a. Square-D
 - b. Westinghouse
 - c. General Electric
 - d. ITE
 - e. Hoffman Engineering Co.
 - f. Lee Products
 - g. Crenlo, Inc.
 - h. Hammond Manufacturing
 - i. Electromate Corporation
2. Sheet Aluminum: Hennessy Products, Inc.

2.2 CABINETS AND BOXES - GENERAL

- A. Electrical Cabinets and Boxes:** Of indicated types, sizes and NEMA enclosure classes. Where not indicated, provide units of types, sizes and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations.

2.3 MATERIALS AND FINISHES

- A. Sheet Steel:** Flat-rolled, code-gage, galvanized steel.
- B. Fasteners for General Use:** Corrosion resistant screws and hardware including cadmium and zinc plated items.
- C. Fasteners for Damp or Wet Locations:** Stainless steel screws and hardware.
- D. Cast Metal for Boxes, Enclosures and Covers:** Copper-free aluminum except as otherwise specified.
- E. Exterior Finish:** Gray baked enamel for items exposed in finished locations except as otherwise indicated.
- F. Painted Interior Finish:** Where indicated, white baked enamel.

- G. Fittings for Boxes, Cabinets and Enclosures: Conform to UL 514B. Malleable iron or zinc plated steel for conduit hubs, bushings and box connectors.

2.4 STEEL DEVICE BOXES

- A. Fabricate from galvanized or cadmium plated pressed sheet steel, with covers, extension, etc., as required by the installation.
- B. Switch Boxes
 - 1. Single gang - 2 inch wide by 3 inch long by 1-1/2 inch depth minimum.
 - 2. Two gang - 4 inch square by 2-1/8 inch deep.
 - 3. Multi-gang - 4-1/2 inch high by 2-1/8 inch deep by width as required by number of gangs.
- C. Outlet, Receptacle, Device and Junction Boxes
 - 1. 4 inch square by 1-1/2 inch depth minimum, without clamps for either conduit or tubing.
 - 2. 4-11/16 inch square by 1-1/2 inch depth minimum, without clamps for either conduit or tubing.

2.5 CAST DEVICE BOXES

- A. Copper-free aluminum or malleable iron with matching cast cover.
- B. Switch Boxes: FS or FD series, single, two, multi-gang as required for wiring device arrangement.
- C. Outlet, Receptacle, Device and Junction Boxes: FD series, single, two, multi-gang as required for wiring device arrangement.

2.6 FLOOR BOXES

- A. General: All floor boxes shall be Wiremold. For Installation of Voice, Data and Fiber Connectors in Wiremold 4000:

<u>Part No.</u>	<u>Manufacturer</u>	<u>Description</u>
V4050	Wiremold	Device Bracket
5507D	Wiremold	Duplex Cover
5507B	Wiremold	Blank Cover
V4000B-10	Wiremold	Base
V4000C	Wiremold	Cover

G4000D	Wiremold	Divider
4001D	Wiremold	Divider Clip
V4011FO	Wiremold	Flat 90 Degree Angle

Floor Box on Grade

RFB4-CI-1	Wiremold	Slab on Grade Box
S37BBTCAL	Wiremold	Flangeless Activation Kit for Carpet
S36BBTCAL	Wiremold	For Tile
CIHT-D	Wiremold	Duplex Bracket

Floor Box Above Grade

RFB4-SS	Wiremold	Above Grade Box
S37BBTCAL	Wiremold	Flangeless Activation Kit for Tile
S36BBTCAL	Wiremold	For Carpet
RFB-RB-SS	Wiremold	Duplex Bracket

2.7 PULL AND JUNCTION BOXES

- A. NEMA type and size as required by area or as shown, complete with matching cover. Where necessary, gaskets shall be used to prevent entrance of moisture.
- B. Galvanized Sheet Steel: Minimum 14 gauge, solder or braze all seams, roll edges at openings and bolt on covers.
- C. Cast Iron: Corrosion resistant, hot-dip galvanized and bolt on cast cover utilizing stainless steel screws.
- D. Cast Aluminum: Non-rusting, non-sparking, non-magnetic and bolt on cast cover utilizing stainless steel screws.
- E. Cast Bronze: Non-rusting, non-sparking, non-magnetic and bolt on cast cover utilizing brass screws

2.8 CABINETS

- A. Comply with UL 50, "Electrical Cabinets and Boxes."
- B. General: NEMA type and size as required by area, application, or as shown. Cabinet

shall consist of a box and a front consisting of a one-piece frame and hinged door. Hinged side shall be dependent upon physical application. Arrange door to close against a rabbet placed around the inside edge of the frame, with a uniformly close fit between door and frame. Provide concealed fasteners, not over 24 inches apart, to hold fronts to cabinet boxes and provide for adjustment. Provide flush or concealed door hinges not over 24 inches apart and not over 6 inches from top and bottom of door. Louvers for cabinet ventilation shall be provided as required by application. For flush cabinets, make the front approximately 3/4 inch larger than the box all around. For surface mounted cabinets make front same height and width as box.

- C. Doors: Double doors for cabinets wider than 24 inches. Telephone cabinets wider than 48 inches may have sliding or removable doors.
- D. Locks: Combination spring catch and key lock, with all locks for cabinets of the same system keyed alike. Locks may be omitted on signal, power and lighting cabinets located within wire closets and mechanical-electrical rooms. Locks shall be of a type to permit doors to latch closed without locking. Latch shall be padlocking type for exterior applications.
- E. Galvanized Sheet Steel: Minimum 14 gauge, solder or braze all seams, roll edges at openings and minimum 12 gauge doors to match panelboard enclosures.
- F. Sheet Aluminum: Minimum .125 inch 5052-H32 sheet aluminum thickness, welded seams, gasketed weathertight door, weather-resistance hinge, and weather-resistant padlockable latching mechanism.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install items where indicated and where required to suit code requirements and installation conditions.
- B. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.
- C. Support and fasten items securely in accordance with Section 260190 - Supporting Devices.
- D. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.
- E. Remove sharp edges where they may come in contact with wiring or personnel.

3.2 APPLICATIONS

- A. Cabinets: Flush mounted, NEMA enclosure type 1 except as otherwise indicated.
- B. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types suitable for each location and in conformance with the following requirements.
 - 1. Interior Dry Locations: Sheet steel, NEMA type 1.
 - 2. Locations Exposed to Weather or Dampness: Cast metal, NEMA type 3R.
 - 3. Wet Locations: NEMA type 4 enclosures.
 - 4. Hazardous (Classified) Locations: NEMA type listed and labeled for the location and class of hazard indicated.
- C. Pull and Junction Boxes: Install pull and junction boxes of materials and NEMA types suitable for each location except as otherwise indicated.
- D. Floor Boxes: In slabs on grade and wet locations use NEMA type 4 boxes. At other locations in slabs, use concrete-tight NEMA 1 boxes.

3.3 INSTALLATION OF BOXES

- A. Size all boxes as required by the National Electrical Code with oversize boxes as shown on Drawings. Obtain special back boxes with associated equipment when available.
- B. Provide where required for outlet facility and rough-in requirements. Securely support from building construction with rods or bar hangers independent of raceways. Provide backing extension for all steel device boxes in stud walls or support box on two opposite sides such that cover plate and drywall is not stressed to hold box in position.
- C. Give priority in available space to large steam mains, steam lines that pitch, waste lines, drain lines, large air duct, and all structural steel, unless shown otherwise.
 - 1. Minimum Spacing: 3 inches between boxes and cold water or waste piping and 6 inches between boxes and parallel steam pipes, condensate pipes, hot water pipes and air ducts.
 - 2. Do not support from ceiling supporting system, mechanical system supports or mechanical systems.
 - 3. Do not penetrate or anchor into mechanical ductwork.
- D. Install recessed except where shown or specified surface mounted.
- E. Maintain accessibility to all boxes. Z-spline ceilings are considered not accessible.
- F. Size and install so no parts are visible and completely covered by wall plate or fixture.

- G. Do not cut insulation in walls to install boxes.
- H. Do not use through-the-wall boxes.
- I. Recessed boxes shall not be installed back to back (stagger horizontally).
- J. Install in center of glazed tile, brick, block or other masonry wall material with square cornered tile or masonry extension rings of proper depth.
- K. Install outlet boxes in sheet rock walls with square cornered tile or masonry rings of proper depth. Standard drywall rings are acceptable. Maintain NEC required tolerances.
- L. Close off all unused openings with proper fittings.
- M. Install outlet boxes for electric water coolers concealed inside cooler cabinet. Locate outlet boxes using rough-in template furnished with cooler.
- N. Use multi-gang cast device boxes whenever possible unless specifically noted otherwise for adjacent multi-device installations.
- O. Combination devices (i.e., switch and receptacle) installed in minimum 2 gang box under common cover. Provide barriers to segregate voltages 300 volts and greater and to segregate normal and emergency distribution system branches.
- P. Combination receptacle and communications devices (i.e., television and receptacle) shall be installed in minimum 2 gang boxes with barriers to segregate the systems.

3.4 INSTALLATION OF PULL AND JUNCTION BOXES

- A. All boxes shall be concealed and accessible after completion of building.
- B. Installation in finished spaces requiring access panels is prohibited except where specifically shown or directed.

3.5 BOX MARKING

- A. Mark box cover on exterior in unfinished areas (including accessible ceiling spaces) and interior of box in finished areas with the following:
 - 1. Load served.
 - 2. Circuit origin and number.
- B. Paint cover of box in unfinished areas and in accessible ceiling spaces:
 - 1. Fire alarm - red.

2. Life safety - yellow.
3. Critical - blue.
4. General emergency - green.
5. Communications - independent color for each system as directed by Owner.

3.6 BOX COVERS

- A. Provide appropriate screw cover for all boxes depending upon type and application.

3.7 BOX APPLICATION

- A. Galvanized steel boxes may be used in:
 1. Concealed interior locations above ceilings and in hollow studded partitions.
 2. Exposed interior location above seven feet.
 3. Direct contact with concrete except slab on grade.
 4. Stud walls of kitchens and laundries.
- B. Cast boxes shall be used in:
 1. Exterior locations.
 2. Hazardous locations.
 3. Within seven feet area around boilers, incinerators and other heat producing equipment.
 4. Exposed interior locations within seven feet of the floor.
 5. Direct contact with earth.
 6. Direct contact with concrete in slab on grade.
 7. Wet locations.
 8. Kitchens and laundries except in stud walls.
- C. Sectional Boxes shall not be used in any application.

3.8 INSTALLATION OF CABINETS

- A. Support securely from building construction and align with adjacent equipment. Maximum height of top shall be less than 6 foot - 6 inches.

3.9 GROUNDING

- A. Electrically ground metallic cabinets, boxes and enclosures. Where wiring to item includes a grounding conductor, provide a grounding terminal in the interior of the cabinet, box or enclosure.

3.10 CLEANING AND FINISH REPAIR

- A. Upon completion of installation, inspect components. Remove burrs, dirt and construction debris and repair damaged finish including chips, scratches, abrasions and weld marks.
- B. Galvanized Finish: Repair damage using a zinc-rich paint recommended by the tray manufacturer.
- C. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating.

END OF SECTION

SECTION 260143 WIRING DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Instructions to Bidders, and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this section:
 - 1. Section 260010 - Basic Electrical Requirements.
 - 2. Section 260050 - Basic Electrical Materials and Methods.
 - 3. Section 260170 - Circuit and Motor Disconnects for devices other than snap switches and plug/receptacle sets used as disconnects for motors.
 - 4. Section 260195 - Electrical Identification for requirements for legends to be engraved on wall plates.

1.2 SUMMARY

- A. This Section includes the following wiring devices, wiring device accessories, and wiring device assemblies.
 - 1. Switches
 - 2. Receptacles
 - 3. Plug Connectors
 - 4. Wall Plates
 - 5. Floor Service Boxes
 - 6. Pilot Lights

1.3 SUBMITTALS

- A. Product data for each type of product specified.
- B. Samples of those products indicated for sample submission in Architect's comments on product data submittal. Include color and finish samples of device plates and other items per Architect's request.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with provisions of the following codes.

- B. NFPA 70 - National Electrical Code.
- C. UL and NEMA Compliance: Provide wiring devices which are listed and labeled by UL and comply with applicable UL and NEMA standards.
- D. Underwriters Laboratories Inc. (UL):
 - 1. UL 20-86 General-Use Snap Switches.
 - 2. UL 498-86 Electrical Attachment Plugs and Receptacles.
 - 3. UL 943-85 Ground-Fault Circuit Interrupters.
 - 4. UL 486A-80 Wire Connectors and Soldering Lugs for Use with Copper Conductors.
 - 5. UL 1010-86 Receptacle-Plug Combinations for Use in Hazardous (classified Locations).
- E. National Electrical Manufacturers Association (NEMA):
 - 1. Std Pub/No. FB 11-83 Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.
 - 2. Std Pub/No. PR 2-86 Enclosures for Plugs, Receptacles and Connectors of the Pin and Sleeve Type.
 - 3. Std. Pub/No. PR 3-86 Guide to Pin and Sleeve Plugs, Receptacles, and Connectors.
 - 4. Std Pub/No. WD 1-85 General-Purpose Wiring Devices.
 - 5. Std Pub/No. WD 6-83 Wiring Devices Dimensional Requirements.

1.5 SEQUENCE AND SCHEDULING

- A. Protect wiring devices if installed prior to painting.
- B. Schedule installation of finish plates after the surface upon which they are installed has received final finish.

PART 2 PRODUCTS

2.1 WIRING DEVICES:

- A. General: Provide wiring devices, in types, characteristics, grades, colors, and electrical ratings for applications indicated which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA standards.
 - 1. Provide white color switches.
 - 2. Provide gray color receptacles for K-rated circuits.
 - 3. Provide red color receptacles for emergency circuits.

4. Provide white color receptacles for normal power circuits.
- B. Receptacles: Comply with UL 498 and NEMA WD 1.
- C. Ground-Fault Interrupter (GFI) Receptacles: Provide "feed-thru" type ground-fault circuit interrupter, with integral heavy-duty NEMA 5-20R duplex receptacles arranged to protect connected downstream receptacles on same circuit. Provide unit designed for installation in a 2-3/4 inch deep outlet box without adapter, grounding type, Class A, Group 1, per UL Standard 943.
- D. Plug Connectors: 20 amperes, 125-volts, bakelite-body armored connectors, 3-wire, grounding, parallel blades, double wipe contact, with cord clamp, and 0.4 inch cord hole, match NEMA configuration to mating plug's. Arrange as indicated.
- E. Switches: quiet type AC switches. Comply with UL 20 and NEMA WD1. 120/277V.20 ampere (SPST) (Three Way) (Four Way)

2.2 WIRING DEVICE ACCESSORIES

- A. Wall plates: single and combination, of types, sizes, and with ganging and cutouts as indicated. Provide plates which mate and match with wiring devices to which attached. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates. Provide wall plate color to match wiring devices except as otherwise indicated. Provide wall plates with engraved legend where indicated. Conform to requirements of Section 260195 - Electrical Identification. Provide plates possessing the following additional construction features:
 1. Material and Finish: steel plate with wrinkled finish, baked-on insulating enamel. In finished interior areas.
 2. Material and Finish: 0.04 inch thick, type 302 satin brushed stainless steel. Toilet and kitchen areas.
 3. Material and Finish: Steel Plate, Galvanized in equipment rooms.
- B. Floor Services Boxes:
 1. Visible: Bronze edge ring and floor plate, exterior leveling screws, vertical and angular adjustable both before and after concrete pour. Carpet or tile plate assemblies as required by outlet and floor construction.
 - a. Water Tight: Cast iron with threaded conduit openings, 4-1/4 inch square, depth as required for floor construction with corrosion resistant finish.
 - b. Concrete tight: Galvanized stamped steel 4-11/16 inch square.
 - c. Flush floor plates
 - 1) Receptacle - brass hinged lift lid.
 - 2) Telephone - 3/4 inch and 2 inch diameter plug.
 - 3) Computer - 3/4 inch and 2 inch diameter plug.

- d. Floor Station Stem: 1/2 inch diameter by one inch high of same material as service fitting.
 - e. Above Floor Service Fitting
 - 1) Brushed satin aluminum finish on all exposed surfaces.
 - 2) Type and quantity of outlets shown on Drawings. Telephone and computer outlets shall have 3/4 inch diameter grommeted holes.
2. Concealed
- a. Recessed galvanized stamped steel floor box with space for both high tension and low tension wiring. Fully adjustable prior to and after concrete pour. Hinged access cover to accept floor covering and be operable without exposing any metal parts.
 - b. Weatherproof Cover Plate
 - c. Provide as shown on Drawings, identical to P and S 4600 series for outdoor applications and P and S 4500 series for indoor applications.
3. Tester: Provide two receptacle circuit testers and two ground fault interrupter testers. Give to owner upon completion.

2.3 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Switches, Specification Grade:
 - a. 20 amp 120-277 volt.
 - 1) Arrow Hart - 1991 series
 - 2) Bryant - 4900 series
 - 3) Hubbell - 1200 series
 - 4) Pass and Seymour - 20 AC series
 - 5) Eagle - 2221 series
 - b. 20 amp 120-277 volt, momentary contact, center off, SPDT.
 - 1) Arrow Hart - 1995 series
 - 2) Bryant - 4921 series
 - 3) Pass and Seymour - 1251 series
 - 4) Eagle - 2220 series
 - c. 20 amp 120-277 volt, maintained contact, three position, center off
 - 1) Arrow Hart - 4360 series
 - 2) Bryant - 4920 series
 - 3) Hubbell - 1380 series
 - 4) Pass and Seymour - 1220 series
 - 5) Eagle - 1206 series

2. Duplex Receptacles, Specification Grade:
 - a. 20 amp 125 volt, heavy duty, premium specification grade, grounding type straight blade, NEMA 5-20R Standard face.
 - 1) Arrow-Hart - 5362 series
 - 2) Bryant - 5362 series
 - 3) Hubbell - 5352 series
 - 4) Pass and Seymour - 5362 series
 - 5) Eagle - 5362 Series
 - b. Ground fault interrupting, feed-thru type, 20 amp 125 volt, heavy duty, premium specification grade, grounding type, straight blade, NEMA 5-20R.
 - 1) Arrow Hart - GF-5342
 - 2) Bryant - GFR83
 - 3) Hubbell - GF-5362 series
 - 4) Eagle – 647
 - c. Ground fault interrupting, feed-thru type, 20 amp 125 volt, grounding type straight blade, NEMA 5-20R.
 - 1) Arrow Hart - GF-8300
 - 2) Hubbell - GF-8300 series
 - 3) Pass and Seymour - 2091 FHG

B. Special Purpose Receptacles

1. Electric dryer receptacles - 30 amp, 125/250 volt, heavy duty specification grade, grounding straight blade type, NEMA 14-30 for flush installation.
 - a. Hubbell - 9430
 - b. Leviton - 278
 - c. Pass and Seymour - 5744
 - d. Slater - 3864
 - e. Eagle - 38B
2. Clock hanger type receptacle - 15 amp 125 volt, specification grade, grounding, straight blade type, NEMA 5-15R.
 - a. Hubbell - 5235
 - b. Leviton - 5261-CH
 - c. Pass and Seymour - 2122 series
 - d. Slater - S-373-3-5S
 - e. Eagle - 714

C. Pilot Lights, Jewel type neon pilot mounted under 1-gang of a 2-gang cover.

1. Pass and Seymour - 2151-R or equal

PART 3 EXECUTION

3.1 INSTALLATION OF WIRING DEVICES AND ACCESSORIES:

- A. Install wiring devices and accessories as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other Work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other Work.
- C. Install wiring devices only in electrical boxes which are clean; free from building materials, dirt, and debris.
- D. Install wiring devices after wiring work is completed.
- E. Install wall plates after painting work is completed.
- F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A. Use properly scaled torque indicating hand tool.
- G. In each instance where two or more devices are generally located in the immediate vicinity and at the same mounting height, mount these devices in multi-gang, barriered boxes under a single, one-piece cover plate.
- H. Coordinate wiring device mounting with architectural elevations.
- I. Remote maintained contact emergency stop and rest pushbuttons shall be wired ahead of all other motor control devices and shall interrupt the motor control circuit in both the "Hand" and "Automatic" positions.
- J. Unless otherwise noted, all wall mounted wiring devices shall be mounted vertically.
- K. Lighting switches shall be installed so the upper position of switch handles shall be the "ON" position. (NA 3 Way, 4 Way)
- L. Combination devices (i.e., switch and receptacle) shall be installed in minimum 2 gang boxes with barriers under one common cover.
- M. Combination receptacles and communications devices (i.e., telephone or television and receptacle) shall be installed in minimum 2 gang boxes with barriers to segregate the systems and shall be installed under one common cover.

- N. Devices designated as weatherproof (by suffix WP) shall be ground fault circuit interrupting type and where shown outdoors shall be installed in heavy duty die cast aluminum boxes (Pass and Seymour No. 4600) with lockable weatherproof covers. Where shown indoors shall be installed in standard outlet boxes with weatherproof covers. Provide three keys for Owner.
- O. Receptacles at cabinets shall be mounted 2 inches clear above counter backsplash or as otherwise shown on Drawings. Receptacles at water coolers shall be located behind the cooler as recommended by manufacturer of the cooler.
- P. Unless otherwise noted, duplex receptacles shall be installed vertically with grounding pole up. Duplex receptacles mounted 3'-6" A.F.F. or above shall be installed vertically with grounding pole down.

END OF SECTION

SECTION 260170 CIRCUIT AND MOTOR DISCONNECTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this section:
 - 1. Section 260010 - Basic Electrical Requirements
 - 2. Section 260477 - Fuses
 - 3. Section 260143 - Wiring Devices, for snap switches used as motor disconnects.

1.2 SUMMARY

- A. This Section includes circuit and motor disconnects.
- B. Related Sections: Section 260480 - Motor Controllers for combination type starters which incorporate disconnect switches in the same enclosure as the starter and manual motor starters which include the disconnect function as part of the starter switch assembly.

1.3 SUBMITTALS

- A. Product data for each type of product specified.
- B. Maintenance data for circuit and motor disconnects, for inclusion in operation and Maintenance Manual specified in Division 1 and Division 26 Section "Basic Electrical Requirements."

1.4 QUALITY ASSURANCE

- A. Electrical Component Standards: Provide components complying with NFPA 70 "National Electrical Code", applicable requirements of NEMA standards and which are listed and labeled by UL.
 - 1. National Fire Protection Association (NFPA): No. 70-87 National Electrical Code, NEC.
 - 2. National Electrical Manufacturers Association (NEMA):
 - a. Std. Pub No. 250-85 Enclosures for Electrical Equipment (1000 Volts

- Maximum).
- b. Std. Pub No. KS 1-83 Enclosed Switches.
- 3. Underwriters Laboratories Inc. (UL):
 - a. UL 98-87 Enclosed and Dead-Front Switches.
 - b. UL 869-84 Electrical Service Equipment.
 - c. UL 894-86 Switches for Use in Hazardous Locations, Class I, Groups A, B, C, and D, and Class II, Groups E, F, and G.
 - d. Fused Power Circuit Devices.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. General Electric Co.
 - 2. Square D Company.
 - 3. Eaton/Cutler-Hammer
 - 4. Siemens

2.2 CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. General: Provide circuit and motor disconnect switches in types, sizes, duties, features, ratings, and enclosures as indicated. Provide NEMA 1 enclosure except for outdoor switches, and other locations shown on Drawings provide NEMA 3R enclosures with raintight hubs. For motor and motor starter disconnects, provide units with horsepower ratings suitable to the loads.
- B. Fusible Switches: Heavy duty switches, with fuses of classes and current ratings indicated. See Section "Fuses" for specifications. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses.
- C. Non-fusible Disconnects: Heavy duty switches of classes and current ratings as indicated.
- D. Double-Throw Switches: Heavy duty switches of classes and current ratings as indicated.
- E. Service Switches: Heavy duty fusible switches. UL listed for use as service equipment under UL Standard 98 or 869.
- F. Combination Motors Starter Disconnects: Switch type; fused; quick-make, quick-break switch; factory assembled with controller and arranged to disconnect it. For fused

switches, provide

rejection-type fuse clips and fuses rated as indicated. Switches and fuses are specified in Division 26 Section "Overcurrent Protective Devices." Interlock switch with unit cover or door.

1. Control Circuit: 120 V. Provide control power transformer integral with controller where no other supply of 120 V control power to controller is indicated. Provide control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
2. Enhanced-Protection Overload Relay: Provide overload relays with NEMA Class 10 tripping characteristics where indicated. Select to protect motor against voltage unbalance and single phasing.
3. Hand Off Automatic controller: Provide factory wired HAND-OFF-AUTOMATIC selectors integral with the combination controllers.

2.3 ACCESSORIES

- A. Electrical Interlocks: Provide number and arrangement of interlock contacts in switches as indicated.
- B. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:
 1. Stainless Steel Type 304.
 2. Molded fiberglass reinforced plastic.
 3. Heavy cast aluminum.
- C. Captive Fuse Pullers: Provide built-in fuse pullers arranged to facilitate fuse removal.
- D. Starters: Provide magnetic across the line starters with thermal overload relays sized for the motor.

PART 3 EXECUTION

3.1 INSTALLATION OF CIRCUIT AND MOTOR DISCONNECTS

- A. General: Provide circuit and motor disconnect switches as indicated and where required by the above Code. Comply with switch manufacturers' printed installation instructions.

3.2 FIELD QUALITY CONTROL

- A. Testing: Subsequent to completion of installation of electrical disconnect switches, energize circuits and demonstrate capability and compliance with requirements. Except

as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation, and for verification of type and rating of fuses installed. Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.

END OF SECTION

SECTION 260190 SUPPORTING DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Instructions to Bidders and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this section:
 - 1. Section 260010 - Basic Electrical Requirements.
 - 2. Section 260050 - Basic Electrical Materials and Methods.

1.2 SUMMARY

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.
- B. This Section includes secure support from or to the building structure for seismic support of electrical items by means of vibration isolators and restraining devices.
- C. Related Sections: The following Sections contains requirements that relate to this Section:
 - 1. Division 3 Section "CIP Concrete" for inserts, anchors, and sleeves to be installed in concrete for use with supporting devices.
 - 2. Division 5 Section "Metal Fabrications" for requirements for miscellaneous metal items involved in supports and fastenings.
 - 3. Division 7 Section "Joint Sealers" for requirements for firestopping at sleeves through walls and floors that are fire barriers.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified.
- C. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and

fastener to be used.

- D. Shop drawings indicating details of fabricated products and materials showing compliance with these specifications.
- E. Engineered Design consisting of details and engineering analysis for supports for the following items:
- F. Vibration Isolation: An itemized list showing the items of equipment to be isolated, the isolator type and model selected, isolator loading and deflection and isolation displacement and calculations.
- G. Restraining Devices: Submit seismic calculations for restraints for all switchboards, transformers, motor control centers, etc., and freestanding equipment.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Component and installation shall comply with NFPA 70 National Electrical Code.
- B. Electrical components shall be listed and labeled by UL, ETL, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.
- C. Office of Statewide Planning and Development (OSHPD) R-number anchorage pre-approval list, 12/29/89 printing.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Slotted Metal Angle and U-Channel Systems:
 - a. Allied Tube & Conduit
 - b. American Electric (Superstrut)
 - c. B-Line Systems, Inc.
 - d. Cinch Clamp Co., Inc.
 - e. GS Metals Corp.
 - f. Haydon Corp.
 - g. Kin-Line, Inc.
 - h. Unistrut Diversified Products

2. Conduit Sealing Bushings:
 - a. Bridgeport Fittings, Inc.
 - b. Cooper Industries, Inc.
 - c. Elliott Electric Mfg. Corp.
 - d. GS Metals Corp.
 - e. Killark Electric Mfg. Co.
 - f. Madison Equipment Co.
 - g. L.E. Mason Co.
 - h. O-Z/Gedney
 - i. Producto Electric Corp.
 - j. Raco, Inc.
 - k. Red Seal Electric Corp.
 - l. Spring City Electrical Mfg. Co.
 - m. Thomas & Betts Corp.

3. Vibration Isolators
 - a. California Dynamics Company
 - b. Mason Industries

2.2 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.3 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

- B. Fasteners: Types, materials, and construction features as follows:
 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 2. Toggle Bolts: All steel springhead type.
 3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.

- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded

body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

- E. U-Channel Systems: 12-gauge steel channels, with 9/16-inch-diameter holes, at a minimum of 6 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

2.4 VIBRATION ISOLATORS

- A. General: Provide vibration isolators with either known undeflected heights or other markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
- B. Provide isolators that operate in the linear portion of the load versus deflection curve. Furnish load versus deflection curves from the manufacturer that are linear, over a deflection range 50% above the design deflection.

C. Vibration Isolator Types

1. General Properties

- a. All vibration isolators shall have either undeflected heights, or calibration markings, so that, after adjustment when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
- b. All isolators shall operate in the linear portion of their load versus deflection curve. Furnish load versus deflection curves from manufacturer; curves must be linear over a deflection range of not less than 50% above the design deflection.
- c. The ratio of lateral to vertical stiffness shall be not less than 0.9, nor greater than 1.5.
- d. The theoretical vertical natural frequency for each support point, based upon the load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than (+/-) 10%.
- e. Wave motion through the isolator shall be reduced to the following extent: Isolation above the primary vertical system resonance frequency shall follow the theoretically predicted isolation curve for single degree of freedom systems with 10 db to 50 db at all frequencies above the 150 Hz.
- f. All neoprene mountings shall have a shore hardness of 40-65 after minimum aging of 30 days, or corresponding open-aging.

D. Isolator Description

1. Type MS shall be spring type, without housings or snubbers, equipped with leveling bolts and with two layers of ribbed or waffled neoprene pads, separated by a 1/16" galvanized steel plate under the base plate. Neoprene sleeves and washer shall be installed at all anchor bolts.
2. Type HS shall be suspension hangers having a steel frame and spring element, in series with a neoprene pad, cut or washer. The isolator shall be designed so that hanger rod may be misaligned 15 degrees in any direction relative to the vertical, without contacting hanger box frame.
3. Type MN shall be neoprene isolator support type unit having a minimum static deflection of 1/4".
4. Type HN shall be a suspension hanger type employing a neoprene isolator unit having a minimum static deflection of 1/4".

E. Equipment Frames

1. Mounting frames and brackets shall be provided to carry the load of the equipment without causing mechanical distortion or stress to the equipment.
2. The mounting frames shall consist of welded, wide flange or channel structural steel, with welder brackets to accept the isolators. The section depth of any frame member shall be not less than 1/10th of the length of the longest frame member, and not less than 1/10th of the greatest span between support points. All frame members shall have the same depth.

2.5 FABRICATED SUPPORTING DEVICES

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide pipe sleeves of one of the following:

2.6 SHEET METAL:

- A. Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:
- B. 3-inch and smaller: 20-gauge.
- C. 4-inch to 6-inch: 16-gauge.
- D. Over 6-inch: 14-gauge.

1. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
2. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.
3. Restraining Devices

E. Materials

1. Restraints shall consist of 2" by 1/4" flat iron bars with resilient pads to provide vertical and lateral restraining during seismic shock.
2. Each restraint shall consist of two pieces of lat iron bars bolted together with two 3/8" bolts and serrated washers. The holes in the bars shall be slotted vertically to permit adjustment for required clearance.
3. Refer to contract drawings for additional requirements.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install supporting devices to fasten electric components securely and permanently in accordance with NEC requirements.
- B. Coordinate with the building structural system and with other electrical installation.
- C. Raceway Supports: Comply with the NEC and the following requirements:
 1. Conform to manufacturer's recommendations for selection and installation of supports.
 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs, provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
 6. Space supports for raceways in accordance with Table I of this section. Space supports for raceway types not covered by the above in accordance with NEC.
 7. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be

- omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
- D. Vertical Conductor Supports: Install simultaneously with installation of conductors.
 - E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
 - F. In open overhead spaces, cast boxes threaded to raceways shall be supported separately support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
 - G. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for raceways and cable installations. For sleeves through fire-rated wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with "Fire Resistant Joint Sealers" requirement of Division 7 Section "Joint Sealers."
 - H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
 - I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
 1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
 2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 3. Ensure that the load applied to any fastener does not exceed 25% of the proof test load. Use vibration and shock resistant fasteners for attachments to concrete slabs.

J. Vibration Isolators:

1. All floor supported transformers of less than 75 KVA located within the building shall be mounted on vibration isolation rails utilizing type MN neoprene mounts selected to deflect a minimum of 0.25".
2. Bolt 3 KVA transformer to wall as recommended by manufacturer.

K. Restraining Devices: Bolt restraints to floor with 1/2" lag type bolts and anchors. Install restrains after equipment has been set on isolators and after the isolators have been adjusted for required deflection.

TABLE I: SPACING FOR RACEWAY SUPPORTS

Raceway Size (Inches)in Run	No. of Conductors Location	Maximum Spacing of Supports (Feet)		
		RMS&IMC*	EMT	RNC
HORIZONTAL RUNS				
1/2, 3/4 1 or 2	Flat ceiling or wall.	5	5	3
1/2, 3/4 1 or 2	Where it difficult to provide support except at intervals fixed by the building construction.			
1/2, 3/4 3 or more	Any location.	7	7	--
1/2 - 1 3 or more	Any location.	7	7	--
1 & larger 1 or 2	Flat ceiling or wall.	6	6	--
1 & larger 1 or 2	Where it is difficult to provide supports except as intervals fixed by the building construction.		10	10
1 & larger 3 or more	Any location.	10	10	--
Any --	Concealed.	10	10	--
VERTICAL RUNS				
1/2, 3/4 --	Exposed.	7	7	--
1, 1-1/4 --	Exposed.	8	8	--
1-1/2 and larger --	Exposed.	10	10	--
Up to 2 --	Shaftway.	14	10	--
2-1/2 --	Shaftway.	16	10	--
3 & larger--	Shaftway.	20	10	--
Any --	Concealed.	10	10	--

Maximum spacings for IMC above apply to straight runs only. Otherwise, the maximums for EMT apply.

Abbreviations EMT Electrical metallic tubing.
IMC Intermediate metallic conduit.
RMC Rigid metallic conduit.
RNC Rigid nonmetallic conduit.

END OF SECTION

SECTION 260195 ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this section:
 - 1. Section 260010 - Basic Electrical Requirements.
 - 2. Section 260050 - Basic Electrical Materials and Methods.
 - 3. Section 260120 - Low Voltage Wires and Cables, for requirements for color coding of conductors for phase identification.

1.2 SUMMARY

- A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:
 - 1. Buried electrical line warnings.
 - 2. Identification labeling for raceways, cables, conductors and coverplates.
 - 3. Operational instruction signs.
 - 4. Warning and caution signs.
 - 5. Equipment labels and signs.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 9 Section "Painting" for related identification requirements.
 - 2. Refer to other Division 26 sections for additional specific electrical identification associated with specific items.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 National Electrical Code.
- B. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the Identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. American Labelmark Co.
 - 2. Calpico, Inc.
 - 3. Cole-Flex Corp.
 - 4. Emed Co., Inc.
 - 5. George-Ingraham Corp.
 - 6. Ideal Industries, Inc.
 - 7. Kraftbilt
 - 8. LEM Products, Inc.
 - 9. Markal Corp.
 - 10. National Band and Tag Co.
 - 11. Panduit Corp.
 - 12. Radar Engineers Div., EPIC Corp.
 - 13. Seton Name Plate Co.
 - 14. Standard Signs, Inc.
 - 15. W.H. Brady Co.

2.2 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Adhesive Marking Labels for Raceway and Metal-clad Cable: Pre-printed, flexible, self-adhesive labels with legend indicating voltage and service (Emergency, Lighting, Power, Light, Power d.c., Air Conditioning, Communications, Control, Fire).
- B. Label Size: as follows:
 - 1. Raceways 1-Inch and Smaller: 1-1/8 inches high by 4 inches long.
 - 2. Raceways Larger than 1-Inch: 1-1/8 inches high by 8 inches long.
- C. Color: Black legend on orange background.
- D. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl

tape not less than 3 mils thick by 1 inch to 2 inches in width.

- E. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Raceway and Cable Identification: Flexible acrylic bands sized to suit the raceway diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the raceway or cable.
- F. Underground Line Marking Tape: Permanent, bright-colored, continuous-printed, plastic tape compounded for direct-burial service not less than 6 inches wide by 4 mils thick. Printed legend indicative of general type of underground line below.
- G. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.
- H. Aluminum, Wraparound, Cable Marker Bands: Bands cut from 0.014-inch thick, aluminum sheet, fitted with slots or ears for securing permanently around wire or cable jacket or around groups of conductors. Provide for legend application with stamped letters or numbers.
- I. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field-printed legends to suit the application. Orange background, except as otherwise indicated, with Eyelet for fastener.
- J. Aluminum-Faced Card Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inches thick, and laminated with moisture-resistant acrylic adhesive. Pre-print legend to suit the application, and punch for tie fastener.
- K. Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: 2 inches by 2 inches by 19 gauge.
- L. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in white letters on black face and punched for mechanical fasteners, generally. Emergency equipment shall utilize red face.
- M. Baked-Enamel Warning and Caution Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.
- N. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, preprinted cellulose acetate butyrate signs with 20-gage, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide 1/4-inch grommets in corners for mounting.
- O. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

- P. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50 deg F to 350 deg F. Provide ties in specified colors when used for color coding.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.
- B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.
- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- D. Conduit Identification:
 - 1. Identify each new exposed and concealed raceway shown on the single line riser diagram every 20 feet with the installed conductor operating voltage and distribution system designation using stencil and enamel spray paint. Use red paint for emergency feeders, black paint for normal feeders and orange paint for each side of medium voltage cable tray. (i.e., 208 VOLT LIFE SAFETY, 460 VOLT GENERAL, 208 VOLT NORMAL, 277 VOLT EMERGENCY, etc.). The following areas shall be identified:
 - a. On entire floor area directly above conduits running beneath and within 12 inches of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
 - b. On wall surfaces directly external to conduits run concealed within wall.
 - c. On all accessible surfaces of concrete envelope around conduits in vertical shafts, exposed at ceilings or concealed above suspended ceilings.
 - d. On entire surface of exposed conduits.
 - 2. Apply identification to areas as follows:
 - a. Clean surface of dust, loose material, and oily films before painting.
 - b. Prime surfaces: For galvanized metal, use single-component acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy-duty acrylic resin block filler. For concrete surfaces, use clear alkali-resistant alkyd binder-type sealer.
 - c. Apply one intermediate and one finish coat of orange silicone alkyd enamel.
 - d. Apply primer and finish materials in accordance with manufacturer's

instructions.

- E. Device Coverplate Identification: Engrave with 1/8 inch high black capital letters designating as follows:
1. Other than NEMA 5-15R and 5-20R receptacles shall be engraved with the following:
 - a. Voltage
 - b. Number of phases.
 - c. Current rating.
 - d. Example: "208/3P/50A"
 2. Emergency NEMA 5-15R and 5-20R receptacles shall be engraved with the following branch circuit source information:
 - a. "EMERGENCY".
 - b. Panelboard number.
 - c. Circuit number.
 - d. Example: "EMERGENCY/1LSL1-3"
 3. Receptacles protected upstream on associated branch circuit by a ground fault circuit I interrupter device shall be engraved "GFCI PROTECTED".
 4. Special systems/communication systems devices (i.e., firephone receptacles) shall be engraved designating device (i.e., FIREPHONE, DATA, EKG, TEL, TV, etc.)
- F. Underground Electrical Line Identification: During trench backfilling, for exterior underground power, signal, and communications lines, install continuous underground plastic line marker, located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.
- G. Limit use of line markers to direct-burial cables.
- H. Install line marker for underground wiring, both direct-buried and in raceway.
- I. Power Circuit Identification: Securely fasten identifying metal tags of aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with 1/4-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-lb test monofilament line or one-piece self-locking nylon cable ties.
- J. Tag or label conductors as follows:
1. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicating source and circuit numbers.

2. **Multiple Circuits:** Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure (except for three-circuit, four-wire home runs), label each conductor or cable. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by means of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
 3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- K. Apply warning, caution, and instruction signs and stencils as follows:
1. Install warning, caution, or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
 2. **Emergency Operating Signs:** Install engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
- L. Install equipment/system circuit/device identification as follows:
- M. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 1/2-inch-high lettering on 1-1/2-inch-high label (2-inch-high where two lines are required), white lettering in black field. Utilize red field for equipment connected to an emergency source. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels with screws for each unit of the following categories of electrical equipment.
1. Panelboards, electrical cabinets, and enclosures.
 2. Access doors and panels for concealed electrical items.
 3. Electrical switchgear and switchboards.
 4. Motor starters.
 5. Pushbutton stations.
 6. Power transfer equipment.
 7. Contactors.
 8. Remote control switches.

9. Control devices.
 10. Transformers.
 11. Frequency converters.
 12. Battery racks.
 13. Power generating units.
 14. Telephone switching equipment.
 15. Clock/program master equipment.
 16. TV/audio monitoring master station.
 17. Fire alarm control panel.
 18. Security monitoring master station or control panel.
 19. Spare fuse cabinets.
 20. Battery chargers.
 21. Communication systems backboards and cabinets.
- N. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.
- O. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

END OF SECTION

SECTION 260420 SERVICE ENTRANCE

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-16 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY:

- A. Extent of service-entrance work is indicated by drawings and schedules.
- B. Types of service-entrance equipment in this section include the following:
 - 1. Circuit-breakers.
 - 2. Fuses.
 - 3. Switches.
- C. Other equipment used for service-entrance.
- D. Wires/cables, raceways, and electrical boxes and fittings are specified in Division-16 Basic Electrical Materials and Methods sections, "Wires and Cables", "Raceways", and "Electrical Boxes and Fittings."

1.3 SUBMITTALS:

- A. Submit manufacturer's data on service-entrance equipment and accessories.
- B. Shop Drawings: Submit dimensioned layouts of service-entrance equipment, including spatial relationships to proximate electrical equipment.
- C. Wiring Diagrams: Submit power, signal and control wiring diagrams for service-entrance work. Differentiate between portions of wiring/cabling that are manufacturer-installed and portions that are field-installed.

1.4 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of service-

entrance equipment, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

- B. **Installer's Qualifications:** Firm with at least 5 years of successful installation experience with projects utilizing service-entrance work similar to that required for this project.
- C. **Electrical Code Compliance:** Comply with applicable local code requirements of the authority having jurisdiction and NEC, including Articles 230, 250, and 338, as applicable to installation, and construction of service-entrances.
- D. **NEMA Compliance:** Comply with applicable construction and installation requirements of the following NEMA standards for service-entrance equipment and accessories:
 - 1. Stds Pub/No. AB 1: Molded-Case Circuit Breakers.
 - 2. Stds Pub/No. AB 3: Molded-Case Circuit Breakers and Application
 - 3. Stds Pub/No. KS 1: Enclosed Switches.
 - 4. Stds Pub/No. PB 2: Deadfront Distribution Panelboards.
 - 5. Stds Pub/No. PB 2.2: Application Guide for Ground-Fault Protective devices for Equipment.
- E. **UL Compliance:** Comply with construction and installation requirements of the following UL standards for service-entrance equipment and accessories.
 - 1. UL 50: Electrical Cabinets and Boxes.
 - 2. UL 489: Molded-Case Circuit Breakers and Circuit-Breaker Enclosures.
 - 3. UL 854: Service-Entrance Cables.
 - 4. UL 869: Electrical Service Equipment.
- F. Provide service-entrance equipment and accessories which are UL-listed and labeled, and marked, "SUITABLE FOR USE AS SERVICE EQUIPMENT."
- G. **IEEE Compliance:** Comply with applicable requirements of IEEE Std 241 pertaining to service entrances.

1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver service-entrance equipment components properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for service-entrance equipment and components which protect equipment from damage. Install gravity measuring meters in containers which indicate whether container has been bumped or dropped. Return G-meters to manufacturer for reuse upon delivery of switchgear. Inspect equipment to ensure that no damage has occurred during shipment.
- B. Store service-entrance equipment in original packaging and protect from weather and

construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

- C. Handle service-entrance equipment carefully to prevent physical damage to equipment and components. Remove packaging, including the opening of crates and containers, avoiding the use of excessive hammering and jarring which would damage the electrical equipment contained therein. Do not install damaged equipment; remove from site and replace damaged equipment with new.

1.6 SEQUENCING AND SCHEDULING:

- A. Schedule delivery of service-entrance equipment which permits ready building ingress for large equipment components to their designated installation spaces. Coordinate delivery of equipment with the installation of other building components.
- B. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- C. Coordinate with other electrical work including raceways, electrical boxes and fittings, and cabling/wiring work, as necessary to interface installation of service-entrance work with other work.

1.7 MAINTENANCE:

- A. Maintenance Stock, Fuses: For types and ratings required, furnish additional fuses, amounting to one unit for every 10 installed units, but not less than 5 units of each.

PART 2 PRODUCTS

2.1 SERVICE-ENTRANCE EQUIPMENT:

- A. General: Provide service-entrance equipment and accessories; of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified.
- B. Circuit Breakers: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.
- C. Molded-Case Circuit Breakers: Provide factory-assembled, molded-case circuit breakers

of frame sizes indicated; rated 1200 amperes, 600-volts, 60 Hz, 3-poles with 75,000 RMS symmetrical interrupting ratings. Provide breakers with permanent thermal and instantaneous magnetic trips in each pole, and with fault-current limiting protection, ampere ratings as indicated. Construct with over center, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle trip indication. Provide push-to-trip button on enclosure cover for mechanically tripping circuit breakers. Construct breakers for mounting and operating in any physical position and operating in an ambient temperature of 40 deg C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated, and with NEMA Type 1 general purpose enclosures.

1. Internal Breaker Accessories: Provide the following internal circuit breaker accessories where indicated:
 - a. Shunt trip.
 - b. Auxiliary contacts.
 - c. Alarm switch.
 - d. Undervoltage trip.
- D. Fuses: Provide fuses complying with Division-16 Service and Distribution section entitled "Fuses," in accordance with the following listed electrical characteristics:
 1. Class RK1 time delay.
 2. Class RK5 time-delay.
- E. Switches: Provide safety switches complying with Division-16 Basic Electrical Materials and Methods section, "Circuit and Motor Disconnects", in accordance with Heavy-Duty Safety Switches, provide with NEMA Type 1 enclosures.
- F. Cables/Wires: Provide cables/wires complying with Division-16 Basic Electrical Materials and Methods section "Low Voltage Wires and Cables," Section 16120.
- G. Raceways: Provide raceways complying with Division-16 Basic Electrical Materials and Methods section "Raceways", in accordance with IMC Steel Conduit, and fittings.

PART 3 EXECUTION

3.1 EXAMINATION:

- A. Examine areas and conditions under which service-entrance equipment and components are to be installed, and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until satisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF SERVICE-ENTRANCE EQUIPMENT:

- A. Install service-entrance equipment as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that service-entrance equipment fulfills requirements. Comply with applicable installation requirements of NEC and NEMA standards.
- B. Install fuses, if any, in service-entrance equipment.
- C. Install ground-fault protection devices complying with electrical winding polarities indicated.
- D. Set field-adjustable GFP devices and circuit breakers for pickup and time-current sensitivity ranges as indicated, subsequent to installation of devices and CB's.
- E. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B, and the National Electrical Code.

3.3 FIELD QUALITY CONTROL:

- A. Prior to energization of service-entrance equipment, check accessible connections for compliance to manufacturer's torque tightening specifications.
- B. Prior to energization of service-entrance equipment, check with ground resistance tester, phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
- C. Prior to energization, check circuitry for electrical continuity, and for short-circuits.

3.4 GROUNDING:

- A. Provide equipment grounding connections for service-entrance equipment as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounding.

3.5 ADJUSTING AND CLEANING:

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred enclosure surfaces to match original finishes.

3.6 DEMONSTRATION:

- A. Upon completion of installation of service-entrance equipment and electrical circuitry, energized circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and retest to demonstrate compliance.

END OF SECTION

SECTION 260425 SWITCHBOARDS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this Section:
 - 1. "Basic Electrical Requirements."
 - 2. "Basic Electrical Materials and Methods."

1.2 SUMMARY

- A. This Section includes low-voltage power service and distribution switchboards and associated auxiliary equipment rated 600 V or less.
- B. Related Sections: The following Division 26 sections contain requirements that relate to this Section:
 - 1. "Overcurrent Protective Devices" for circuit breakers, fusible switches, fuses, and other similar devices used in switchboards.
 - 2. "Electrical Identification" for identification and warning signs for switchboards and switchboard components.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each product and component specified.
- C. Shop drawings for each switchboard including dimensioned plans and elevations, component and device lists, and a single-line diagram showing main and branch bus current ratings and short-time and short-circuit ratings of switchboard.
- D. Shop drawings or other descriptive documentation of optional barriers specified for electrical insulation and isolation.
- E. Shop drawings of utility company metering provisions with indication of approval by utility company.

- F. Shop drawings of spare fuse cabinet showing material, dimensions, and features including storage provisions for fuse cartons.
- G. Schedule of features, characteristics, ratings, and factory settings of individual protective devices.
- H. Manufacturer's Schematic Wiring Diagram.
- I. Point-to-Point Control Wiring Diagram: Differentiating between manufacturer-installed and field-installed wiring (may be submitted upon delivery of switchboard).
- J. Mimic bus diagram and color samples. Submit updated version of diagram reflecting field changes after final switchboard load connections have been made.
- K. Installer Certificate Signed by Contractor: The sign technician for the mimic bus meets the experience qualifications specified under "Quality Assurance."
- L. Qualification data for field-testing organization certificates, signed by the Contractor, certifying that the organization complies with the requirements specified in Quality Assurance below. Include list of completed projects with project names, addresses, names of Architects and Owners, plus other information specified.
- M. Report of field tests and observations certified by the testing organization.
- N. Maintenance data for materials and products, for inclusion in Operating and Maintenance Manual specified in Division 1 and in Division 26 Section "Basic Electrical Requirements."

1.4 QUALITY ASSURANCE

- A. Listing and Labeling: Provide switchboard assemblies that are listed and labeled. The terms "listed" and "labeled": As defined in the National Electrical Code, Article 100.
- B. Field-Testing Organization Qualifications: To qualify for acceptance, the testing organization must demonstrate, based on evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.
- C. Sign Technician Qualifications: Engage an experienced sign technician who is a professional installer/painter of signs to execute the mimic bus.
- D. Mimic Bus Mock-Up: Prior to installation of mimic bus, fabricate the portion of the mimic bus, including lettered graphics and symbols, applicable to one section of the switchboard. Obtain Architect's acceptance of mock-up before starting final unit of Work. Retain accepted mock-up as a standard for judging the balance of mimic bus

execution. Accepted mock-up may become a part of completed Work.

- E. Electrical Component Standard: Components and installation shall comply with NFPA 70, "National Electrical Code."
- F. NEMA Standard: Comply with NEMA Standard PB2, "Deadfront Distribution Switchboards."
- G. UL Standard: Comply with UL 891, "Deadfront Switchboards."
- H. Product Selection for Restricted Space: The Drawings indicate maximum dimensions for switchboard equipment including clearances between switchboard and adjacent surfaces and items. Switchboards having equal performance characteristics and complying with indicated maximum dimensions may be considered.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.
- B. Store so condensation will not occur on or in switchboards. Provide temporary heaters as required to assure avoiding condensation.
- C. Handle switchboards in accordance with NEMA Standard PB2.1, "General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards." Use factory-installed lifting provisions.

1.6 EXTRA MATERIALS

- A. Spare Fuses: Six spares of each type and rating of fuse and fusible devices used. Include spares for:
 - 1. Potential transformer fuses.
 - 2. Control power fuses.
 - 3. Fuses and fusible devices for fused circuit breakers.
- B. Spare Indicating Lights: Six of each type installed.
- C. Touch-Up Paint: Three half-pint containers.

1.7 WARRANTY

- A. Provide a 5 year warranty for all circuit breakers to include parts and labor. The warranty

shall start on the date of the substantial completion certificate.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Eaton/Cutler Hammer
 2. General Electric Co.
 3. Siemens Energy & Automation, Inc.
 4. Square D Co.

2.2 SWITCHBOARDS

- A. Description: Front-connected, front-accessible, with panel-mounted main device, panel-mounted branches, and sections rear aligned.
- B. Description: Front-connected, front-accessible, with fixed, individually mounted main device, panel-mounted branches, and sections rear aligned.
1. Main Device: Individually fixed mounted.
 2. Branch Devices: Panel mounted.
 3. Insulation and isolation for main bus of main section and main and vertical bus of feeder sections.

2.3 FABRICATION AND FEATURES

- A. Enclosure Finish for Indoor Units: Manufacture standard gray finish over a rust inhibiting primer on phosphatizing treated metal surface. Provide painted surfaces that conform to IEEE C37.20.1, "Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear," paragraph 5.2.8.
- B. Utility Metering Compartment: Fabricated compartment and section meeting utility company requirements. Where separate vertical section is required for utility metering, match and align with basic switchboard.
- C. Bus Transition and Incoming Line Pull Sections: Match and align with basic switchboard.
- D. Buses and Connections: Three-phase, four-wire except as otherwise indicated. Features as follows:

1. Phase and Neutral Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.
 2. At load terminals of feeder breakers, provide silver-plated copper bus extensions equipped with pressure terminal connectors for outgoing circuit conductors.
 3. Ground Bus: 1/4-inch by 2-inch minimum size, hard-drawn copper of 98 percent conductivity, and equipped with pressure connector terminations for feeder- and branch-circuit ground conductors. For busway feeders extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 4. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
 5. Contact Surfaces of Buses: Silver plated.
 6. Main Phase Buses, Neutral Bus, and Equipment Ground Bus: Uniform capacity the entire length of the switchboard main and distribution sections. Provide for future extensions from either end by means of bolt holes or other approved method and connecting links.
 7. Neutral Buses: 100 percent of the ampacity of the phase buses except as indicated and equipped with approved pressure connector terminations for outgoing circuit neutral cables. Provide braced neutral bus extensions for busway feeders with neutral conductors.
- E. Bus Bar Insulation: Factory-applied, flame-retardant, 105 deg C minimum tape wrapping of individual bus bars or flame-retardant, spray-applied insulation of the same temperature rating.
1. Sprayed Insulation Thickness: 3 mils, minimum.
 2. Bolted Bus Joints: Insulate with joint covers after assembly. Use secure covers that are easily removed and reinstalled.
 3. Phase Bar Load Runbacks from OCPDs: Increase insulation thickness where clearances prior to insulation are less than required for bare bus.
 4. Substitute insulation methods will be considered upon submission, and where they are shown to provide equivalent electrical and mechanical characteristics to those specified, will be found acceptable.

2.4 OVERCURRENT PROTECTIVE DEVICES (OCPDs)

- A. Comply with requirements of Division 26 Section "Overcurrent Protective Devices" for types of OCPDs indicated. Provide indicated features, ratings, characteristics, and settings.
- B. Future Devices: Where provision for future overcurrent protective devices or space is indicated, equip compartments with mounting brackets, supports, bus connections, and necessary appurtenances, designed for the OCPD types and ampere ratings indicated for future installation of devices.

2.5 OTHER CIRCUIT CONTROL AND PROTECTIVE DEVICES

- A. General: Factory-installed and -tested devices of types listed below, with indicated ratings, settings, and features.
1. Surge Arresters: As specified in IEEE C62.11, "Standards for Metal-Oxide Surge Arresters for AC Power Circuits," or IEEE C62.1 "Surge Arresters for Alternating Current Power Circuits." Coordinate impulse sparkover voltage with system circuit voltage, and provide factory mounting and connection.

2.6 INSTRUMENTATION

- A. Factory Installed Instrument Transformers: NEMA Standard EI 21.1, "Instrument Transformers for Revenue Metering 110 kV BIL and Less," IEEE Standard C57.13, "Requirements for Instrument Transformers," and the following:
1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
 2. Current Transformers: Ratios as indicated and accuracy class suitable for connected relays, meters, and instruments.
 3. Control Power Transformers: Dry type.
 4. Current Transformers for Neutral and Ground Fault Current Sensing: Ground/neutral sensor current transformers located as indicated. Connect secondaries to ground overcurrent relays to provide selective tripping of bus tie and main breaker. Coordinate with feeder breaker ground fault protection.
- B. Factory Installed Multifunction Digital Metering Monitor: UL listed or recognized microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Inputs: From sensors or current transformers from 100/5 through 1200/5 ratings and potential terminals up to 600 V.
 2. Display: Switch selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase currents, each phase, plus or minus 1 percent.
 - b. Phase-to-phase voltages, 3 phase, plus or minus 1 percent.
 - c. Phase-to-neutral voltages, 3 phase, plus or minus 1 percent.
 - d. Megawatts, plus or minus 2 percent.
 - e. Megavars, plus or minus 2 percent.
 - f. Power factor, plus or minus 2 percent.
 - g. Frequency, plus or minus 0.5 percent.
 - h. Megawatt demand with demand interval programmable from 5 to 60 minutes, plus or minus 2 percent.
 - i. Accumulated energy, megawatt hours, plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.

3. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
- C. Factory Installed Ammeters, Voltmeters, and Power Factor Meters: ANSI C39.1, "Requirements for Electrical Analog Indicating Instruments."
 1. Meters: 4-inch diameter or 6-inch square, flush or semiflush, with antiparallax 250-degree scales and external zero adjustment.
 2. Voltmeters: Cover an expanded scale range of normal voltage plus or minus ten percent.
 - D. Factory Installed Instrument Switches: Rotary type with "off" position.
 1. Voltmeter switches: Permit reading all phase-to-phase and phase-to-neutral voltages where a neutral is indicated.
 2. Ammeter switches: Permit reading current in each phase, and shall maintain current transformer secondaries in a closed-circuit condition at all times.
 - E. Factory Installed Feeder Ammeters: 2-1/2-inch minimum size with 90-degree or 120-degree scale. Meter and transfer device with an "off" position shall be located on overcurrent device door for indicated feeder circuits only. In lieu of transfer device, three meters may be provided, one for each phase.
 - F. Factory Installed Watt-Hour Meters: Flush or semiflush type, rated 5 amperes, 120 V, 3 phase, 3 wire, with 3 elements, 15-minute-indicating-demand register, and provision for testing and adding pulse initiation.
 - G. Factory Installed Recording Demand Meter: Useable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval. Meter shall count and control a succession of pulses entering two channels. House in drawout, back-connected case arranged for semi-flush mounting.
 - H. Metering system shall be able to be connected to the building BMS & educational dashboard systems to monitor demand load and other information.
- 2.7 CONTROL POWER (Factory Installed)
- A. General: Where electrically operated devices or ground fault relays requiring external power are indicated, provide 120-V control circuits supplied through secondary disconnect devices from control power transformer.
 - B. Control Power Fuses: Include primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
 - C. Control Wiring: Factory-installed, complete with bundling, lacing, and protection.

Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.8 RATINGS

- A. Provide nominal system voltage, continuous main bus amperage, and short-circuit-current ratings as indicated.
- B. Nominal System Voltage: 460/265 V, 60 Hz.
- C. Main Bus Continuous: 1200 amperes.

2.9 ACCESSORY COMPONENTS AND FEATURES

- A. Spare Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented, steel box or cabinet. Arrange for wall mounting.

2.10 IDENTIFICATION

- A. General: Refer to Division 26 Section "Electrical Identification." Identify units, devices, controls, and wiring with factory-applied labels and signs.
- B. Compartment Nameplates: Engraved laminated plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws.

PART 3 EXECUTION

3.1 INSTALLATION

- A. General: Install switchboards and accessory items in accordance with manufacturers' written installation instructions and the following specifications:
- B. Anchor each switchboard assembly to two 4-inch-minimum channel-iron sills arranged in accordance with manufacturer's recommendations. Attach by tack welding or bolting. Level and grout sills flush with switchboard mounting surface.
- C. Strength, Spacing, and Placement of Equipment Housekeeping Pads: Where a membrane-waterproofed floor or pressure slab is indicated under the switchboard, and where otherwise indicated, provide a concrete housekeeping pad. Provide 4-inch channel sills specified above in the pad. Fabricate pads as follows:
 - 1. Coordinate size of equipment bases with actual unit sizes provided. Fabricate base

- 4 inches larger in both directions than the overall dimensions of the supported unit.
 2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad.
 3. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units.
 4. Place concrete and allow to cure before installation of units. Use Portland cement that conforms to ASTM C 150, 4000-psi compressive strength, and normal weight aggregate.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- E. Operating Instructions: Frame and mount printed, basic operating instructions for switchboards, including control and key interlocking sequences, and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on the front of the switchboards.

3.2 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Electrical Identification."
- B. Mimic Bus: Apply continuously integrated mimic bus to front of switchboard. Arrange in single-line diagram format, using symbols and lettered designations consistent with the approved final mimic bus diagram. Coordinate mimic bus segments with devices in switchboard sections to which applied. Produce a concise visual presentation of the principal switchboard components and connections.
1. Medium: Painted graphics in approved color contrasting with the equipment factory-finish background to represent the bus and components, complete with lettered designations.
 2. Surface Preparation: As specified in Division 26 Section "Electrical Identification."
 3. Execution: In accordance with sample approved under paragraph "Submissions."

3.3 GROUNDING

- A. Connections: As indicated. Tighten connections to comply with tightening torques specified in UL 486A and 486B.
- B. Ground equipment to main electrical ground bus indicated. Provide maximum 20-ohm ground resistance at switchboard location. (Provide additional ground rods as required).

3.4 CONNECTIONS

- A. Tighten switchboard bus joint bolts and electrical connector and terminal bolts in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not stated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Arrange and pay for the services of a factory-authorized service representative to supervise the pretesting and adjustment of switchboard components for a total of 5 working days.
- B. Pretesting: Upon completing installation of the system, perform the following preparations for tests:
 - 1. Make insulation resistance tests of switchboard buses, components, and connecting supply, feeder, and control circuits.
 - 2. Make continuity tests of circuits.
 - 3. Provide set of Contract Documents to test organization. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
 - 4. Provide manufacturer's instructions for installation and testing of switchboard to test organization.
- C. Quality Control Testing Program: Conform to the following:
 - 1. Program Objectives: To assure switchboard installation meets specified requirements, is operational within specified tolerances, provides appropriate protection for systems and equipment, and is suitable for energizing.
 - 2. Procedures: Make field tests and inspections and prepare switchboard for satisfactory operation in accordance with manufacturer's recommendations and these specifications.
 - 3. Schedule tests and notify Architect at least one week in advance of test commencement.
 - 4. Reports: Prepare written reports of test results and observations. Report defective materials and workmanship. Include complete records of adjustments and remedial efforts.
 - 5. Labeling: Upon satisfactory completion of tests and related effort. Apply a label to tested components indicating test results, person responsible, and date.
 - 6. Protective Device Ratings and Settings: Verify indicated ratings and settings and make the final system adjustments of OCPDs in accordance with Division 26 Section "Overcurrent Protection Devices."
- D. Visual and Mechanical Inspections: Include the following inspections and related work:
 - 1. Inspect for defects and physical damage, testing laboratory, labels, and nameplate compliance with up-to-date circuit connections.

2. Verify that potential transformers, including their overcurrent protection and current transformers meet specified requirements.
3. Perform operational test and exercise of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
4. Check switchboard anchorage, area clearances, and alignment and fit of components.
5. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
6. Clean switchboard interior and exterior using manufacturer's approved methods and materials.
7. Perform visual and mechanical inspection and related work for OCPDs as specified in Section "Overcurrent Protective Devices."

E. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:

1. Insulation resistance test of buses and portions of control wiring that disconnect from solid state devices through normal disconnecting features. Insulation resistance less than 100 megohms is not acceptable.
2. Ratio and polarity tests on current and voltage transformers.
3. Ground resistance test on system and equipment ground connections.
4. Calibrate ammeters and voltmeters at midscale. Use check instruments with documented up-to-date calibration traceable to NIST standards.
5. Verify appropriate capacity, overcurrent protection, and operating voltage of control power elements including control power transformer and control power wiring.
6. Calibrate watt-hour and demand meters to 0.5 percent, and verify meter multipliers. Use check instruments with documented up-to-date calibration traceable to NIST standards.
7. Check phasing of alternate supply sources to the same bus.
8. Test overcurrent protective devices as specified in Section "Overcurrent Protective Devices."
9. Arc flash hazard analysis and labeling. Submit report for review.

F. Retesting: Correct deficiencies identified by tests and observations and retest switchboards. Verify by the retests that switchboards meet specified requirements.

3.6 CLEANING

A. Upon completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.7 PROTECTION

- A. Temporary Heating: Apply temporary heat in accordance with manufacturer's recommendation within each section of switchboards throughout periods during which the switchboard is not in a space that is continuously under normal control of temperature and humidity.

3.8 COMMISSIONING

- A. Infrared Scanning: After Substantial Completion, but not more than 2 months after Final Acceptance, perform an infrared scan of switchboard bus joints and connections. Open or remove metal doors, covers, inspection plates, and barriers to make joints and connections accessible to a portable scanner.
- B. Follow-up Infrared Scanning: Perform 2 additional follow-up infrared scans of the same joints and connections, one 4 months after Substantial Completion and one 11 months after Substantial Completion.
- C. Instrument: Use an infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
- D. Record of Infrared Scanning: Prepare a certified report for review and approval that is identifying all connections checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

END OF SECTION

SECTION 260470 PANELBOARDS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this Section:
 - 1. Section 260010 - Basic Electrical Requirements.
 - 2. Section 260050 - Basic Electrical Materials and Methods.
 - 3. Section 260475 - Protective Devices; for circuit breakers, fusible switches, fuses and other devices used in panelboards.

1.2 SUMMARY

- A. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V or less.

1.3 DEFINITIONS

- A. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type panelboard, accessory item, and component specified.
- C. Shop drawings from manufacturers of panelboards including dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:
 - 1. Enclosure type with details for types other than NEMA Type 1.
 - 2. Bus configuration and current ratings.
 - 3. Short-circuit current rating of panelboard.
 - 4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

- D. Wiring diagrams detailing schematic diagram including control wiring, and differentiating between manufacturer-installed and field-installed wiring.
- E. Panel schedules for installation in panelboards. Submit final versions after load balancing.
- F. Maintenance data for panelboard components, for inclusion in Operating and Maintenance Manual specified in Division 1 and in Division 26 Section "Basic Electrical Requirements." Include instructions for testing circuit breakers.

1.5 SUSTAINABLE DESIGN SUBMITTALS

- A. Section 01351 - Sustainable Project Requirements: Requirements for sustainable design submittals.
- B. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.
 - 1. Indoor Air Quality Certificates: Certify volatile organic compound content for each interior adhesive and sealant and related primer.

1.6 QUALITY ASSURANCE

- A. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.
- B. Electrical Component Standard: Components and installation shall comply with NFPA 70, "National Electrical Code."
- C. NEMA Standard: Comply with NEMA PB1, "Panelboards."
- D. UL Standards: Comply with UL 61, "Panelboards," and UL 50, "Cabinets and Boxes."
- E. Provide a 5 year warranty for all circuit breakers to include parts and labor. The warranty shall start on the date of the substantial completion certificate.

1.7 EXTRA MATERIALS

- A. Keys: Furnish six spares for panelboard cabinet locks. All panelboards keyed the same.
- B. Touch-up Paint for surface-mounted panelboards: One half-pint container.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. General Electric Co.
 2. Siemens Energy & Automation, Inc.
 3. Square D Co.
 4. Eaton/Cutler Hammer

2.2 PANELBOARDS, GENERAL REQUIREMENTS

- A. Overcurrent Protective Devices (OCPDs): Provide type, rating, and features as shown on Drawings. Comply with Division 26 Section "Overcurrent Protective Devices," with OCPDs adapted to panelboard installation. Tandem circuit breakers shall not be used. Multipole breakers shall have common trip.
- B. Enclosures: Cabinets, flush or surface mounted as indicated. NEMA Type 1 enclosure.
- C. Front: Secured to box with concealed trim clamps except as indicated. Front for surface-mounted panels shall be same dimensions as box. Fronts for flush panels shall overlap box except as otherwise specified.
- D. Directory Frame: Metal, mounted inside each panel door.
- E. Bus: Hard drawn copper of 98 percent conductivity with 200% rated neutrals.
- F. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.
- G. Service Equipment Approval: Listed for use as service equipment for panelboards having main service disconnect.
- H. Provision for Future Devices: Equip with mounting brackets, bus connections and extensions, and necessary appurtenances, for the OCPD ampere ratings indicated for future installation of devices.
- I. Special Features: Provide the following features for panelboards as shown on Drawings.
1. Hinged Front Cover: Entire front trim hinged to box with standard door within hinged trim cover.
 2. Extra Gutter Space: Dimensions and arrangement as indicated.
 3. Gutter Barrier: Arranged to isolate section of gutter as indicated.
 4. Auxiliary Gutter: Conform to UL 870, "Wireways, Auxiliary Gutters and Associated Fittings."

- 5. Subfeed: OCPD or lug provisions.
- J. Feed-Through Lugs: Sized to accommodate feeders indicated.
- K. All panels and related breakers downstream from main switchboard shall be permitted to be series rated in accordance with manufacturer's data for involved devices.
- L. The contractor shall provide one (1) surge suppression unit to all panels shown on riser diagram. With integral disconnect, current technology model tg80-120/208-3gy or equal. The tvss/filter unit shall be rated at 80,000 amps in l-n, l-g, and n-g and 160,000 amps per phase. The transient voltage surge suppression system shall be of a technology consisting of metal oxide varistors (mov's), circuits designed to suppress transient voltage and divert excess surge currents. The system shall be designed and ul 1449 2nd edition, rev.2005 listed to suppress the surge current per each mode of protection as detailed in this specification. The maximum response time of the system shall not exceed 1 nanosecond. In compliance with NEMA LS-1-1992, paragraphs 2.2.9 and 3.9, each design configuration shall have the maximum single pulse surge current capacity per mode verified through testing.
- M. Factory installed multi-function digital metering monitor including related current transformers and devices to display phases volts & currents demand load, power factor, frequency, energy, etc. Metering system shall be able to be connected to the building BMS & educational dashboard systems to monitor demand load and other information.

2.3 DISTRIBUTION PANELBOARDS

- A. Doors: In panel front, omit single panelboard door in cabinet front for fusible switch panelboards except as shown on Drawings. Secure with vault-type with tumbler lock, all keyed alike.
- B. Branch-Circuit Breakers: Where OCPDs are shown on Drawings to be circuit breakers, use dual element type with inverse time delay for overload and instantaneous element for short circuit, bolt-on breakers that trip free of the handle. Except circuit breakers 225-ampere frame size and greater may be plug-in type where individual positive locking device requires mechanical release for removal.

2.4 IDENTIFICATION

- A. General: Refer to Section 260190 Electrical Identification, for labeling materials.
- B. Panelboard Nameplates: Engraved laminated plastic or metal nameplate for each panelboard mounted with epoxy or industrial cement or industrial adhesive.

PART 3 EXECUTION

3.1 INSTALLATION

- A. General: Install panelboards and accessory items in accordance with NEMA PB 1.1, "General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less" and manufacturers' written installation instructions.
- B. Mounting Heights: Top of trim 6'-6" above finished floor, except as shown on Drawings.
- C. Mounting: Plumb and rigid without distortion of box. Mount flush panels uniformly flush with wall finish.
- D. Circuit Directory: Typed and reflective of final circuit changes required to balance panel loads. Obtain approval before installing.
- E. Install filler plates in unused spaces.
- F. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch empty conduits from panel into accessible ceiling space or space designated to be ceiling space in future. Stub four 1-inch empty conduits into raised floor space or below slab other than slabs on grade.
- G. Auxiliary Gutter: Install where a panel is tapped to a riser at an intermediate location.
- H. Wiring in Panel Gutters: Train conductors neatly in groups, bundle, and wrap with wire ties after completion of load balancing.

3.2 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs in accordance with Section 260190 Electrical Identification.

3.3 GROUNDING

- A. Connections: Make equipment grounding connections for panelboards.
- B. Provide ground continuity to main electrical ground bus.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals, including grounding connections, in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL

486B.

3.5 FIELD QUALITY CONTROL

- A. Visual and Mechanical Inspection: Include the following inspections and related work:
1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
 2. Exercise and perform of operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
 3. Check panelboard mounting, area clearances, and alignment and fit of components.
 4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
 5. Perform visual and mechanical inspection and related work for overcurrent protective devices as specified in Section 260475 Overcurrent Protective Devices.
- B. Electrical tests: Include the following items performed in accordance with manufacturer's instruction:
1. Insulation resistance test of buses and portions of control wiring that disconnected from solid-state devices. Insulation resistance less than 100 megohms is not acceptable.
 2. Ground resistance test on system and equipment ground connections.
 3. Test main and subfeed overcurrent protective devices in accordance with Section 260475 - Overcurrent Protective Devices.
 4. Arc flash hazard analysis and labeling for all 480/277V panelboards. Submit report for review.
- C. Retest: Correct deficiencies identified by tests and observations and provide retesting of panelboards by testing organization. Verify by the system tests that the total assembly meets specified requirements.

3.6 CLEANING

- A. Upon completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.7 COMMISSIONING

- A. Balancing Loads: After Substantial Completion, but not more than two months after Final Acceptance, conduct load-balancing measurements and circuit changes as follows:

1. Perform measurements during period of normal working load as advised by the Owner.
 2. Perform load-balancing circuit changes outside the normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as FAX machines and on-line data processing, computing, transmitting, and receiving equipment.
 3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
 4. Tolerance: Difference between phase loads exceeding 20 percent at any one panelboard is not acceptable. Rebalance and recheck as required to meet this minimum requirement.
- B. Infrared Scanning: After Substantial Completion, but not more than two months after Final Acceptance, perform an infrared scan of each panelboard. Remove fronts to make joints and connections accessible to a portable scanner.
- C. Follow-up Infrared Scanning: Perform one additional follow-up infrared scan of each panelboard 11 months after the date of Substantial Completion.
- D. Instrument: Use an approved infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide calibration record for device used.
- E. Record of Infrared Scanning: Prepare a certified report for review and approval that is identifying panelboards checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

END OF SECTION

SECTION 260475 PROTECTIVE DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 sections apply to this Section:
 - 1. Section 260010 - Basic Electrical Requirements.
 - 2. Section 260050 - Basic Electrical Materials and Methods.
 - 3. Section 260425 - Switchboards.
 - 4. Section 260470 - Panelboards.
 - 5. Section 260477 - Fuses.

1.2 SUMMARY

- A. This Section includes overcurrent protective devices (OCPDs) rated 600 V and below and switching devices commonly used with them.
- B. Panelboards, Switchboards, and Motor Control Centers: Application, installation, and other related requirements for overcurrent protective device installations in distribution equipment are specified in other Division 26 sections.
- C. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.
- D. Ampere-Squared-Seconds: An expression of available thermal energy resulting from current flow. With regard to current-limiting fuses and circuit breakers, the ampere-squared-seconds during fault current interruption represents the energy allowed to flow before the fuse or breaker interrupts the fault current within its current limiting range.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for fuses, fusible switches, circuit breakers, and OCPD accessories specified in this Section, including descriptive data and time-current curves for all protective devices and let-through current curves for those with current limiting characteristics.

Include coordination charts and tables and related data.

- C. Short Circuit Analysis and Coordination Study performed by a registered professional engineer in accordance with ANSI/IEEE Standard 242-1986, "Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems." Submit a full coordination study showing graphically that the OCPDs coordinate selectively with both upstream and downstream components. Include single line diagram, coordinated time-current characteristics, device performance curves, and fault current calculations adequate to demonstrate satisfactory component protection and selective coordination of protective devices. Study shall be commissioned and paid for by Division 26.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
- C. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.
- D. Single-Source Responsibility: Obtain similar OCPDs from a single manufacturer.
- E. Provide a 5 year warranty for all circuit breakers to include parts and labor. The warranty shall start on the date of the substantial completion certificate.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Cartridge Fuses: Refer to Section "Fuses".
 - 2. Fusible Switches:
 - a. General Electric Co.
 - b. Siemens Energy & Automation, Inc.
 - c. Square D Co.
 - d. Eaton/Cutler-Hammer
 - 3. Fused Power Circuit Devices:
 - a. General Electric Co.
 - b. Pringle Electrical Mfg. Co.

- c. Square D Co.
- 4. Molded-Case Circuit Breakers:
 - a. General Electric Co.
 - b. Siemens Energy & Automation, Inc.
 - c. Square D Co.
 - d. Eaton/Cutler-Hammer.
- 5. Combination Circuit Breaker and Ground Fault Circuit Interrupters:
 - a. General Electric Co.
 - b. Siemens Energy & Automation, Inc.
 - c. Square D Co.
 - d. Eaton/Cutler-Hammer

2.2 OVERCURRENT PROTECTIVE DEVICES (OCPDs), GENERAL

- A. General: Provide OCPDs in indicated types, as integral components of panelboards and also as individually enclosed and mounted single units.
- B. Enclosures: NEMA 250 "Enclosures for Electrical Equipment (1,000 Volts Maximum)."

2.3 CARTRIDGE FUSES

- A. NEMA Standard FU1, "Low-Voltage Cartridge Fuses." Unless indicated otherwise, provide nonrenewable cartridge fuses of indicated types, classes, and current ratings that have voltage ratings consistent with the circuits on which used. Refer to Section 260477 "Fuses".

2.4 FUSIBLE SWITCHES

- A. General: UL 98 "Enclosed and Dead Front Switches" and NEMA KS 1 "Enclosed Switches," quick-make, quick-break heavy-duty units.
- B. Rating: Load-breaking capacity in excess of the normal horsepower rating for the switch.
- C. Withstand Capability: In excess of the let-through current permitted by its fuse when subject to faults up to 100,000 RMS symmetrical amperes.
- D. Operation: By means of external handle.
- E. Interlock: Prevents access to switch interior except when in "off" position.
- F. Fuse Clips: Rejection type.

- G. Padlocking Provisions: For 2 padlocks, whether open or closed.
- H. Enclosure for Independent Mounting: NEMA Type 1 enclosure except as otherwise shown on Drawings or required to suit environment where located.

2.5 FUSED POWER CIRCUIT DEVICES

- A. General: UL 977, "Fused Power Circuit Devices," with either bolted-pressure-type or high-pressure contact-type switch.
- B. Operation: Manually closed, electrically tripped.
- C. Ground Fault Protection: Integral, self-powered type with mechanical ground fault indicator, test function, adjustable pick-up current and delay time with inverse and constant time characteristics, internal memory arranged to integrate intermittent arcing ground faults, and ground fault current sensor located as indicated.
- D. Open Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.
- E. Enclosure for Switchboard Mounting: Suitable for individual mounting.
- F. Enclosure for Independent Mounting: NEMA Type 1 enclosure, except as indicated or except as required to suit environment where located.
- G. Minimum Fault Current Rating: As indicated.

2.6 MOLDED-CASE CIRCUIT BREAKERS

- A. General: UL 489, "Molded Case Circuit Breakers and Circuit Breaker Enclosures," and NEMA AB 1, "Molded Case Circuit Breakers."
- B. Characteristics: Frame size, trip rating and number of poles as shown on Drawings. Minimum short-circuit interrupting capacity shall be 10,000 amperes symmetrical, with greater ratings as shown on Drawings.
- C. Tripping Device: Quick-make, quick-break toggle mechanism with inverse-time delay and instantaneous overcurrent trip protection for each pole.
- D. Adjustable Instantaneous Trip Devices: Factory adjusted to low-trip-setting current values.
- E. Enclosure for Switchboard or Panelboard Mounting: Suitable for panel mounting in switchboard or panelboards where indicated.

- F. Enclosure for Independent Mounting: NEMA Type 1 enclosure, except as otherwise indicated or required to suit environment where located.
- G. Breakers downstream from main switchboard shall be permitted to be series rated in accordance with manufacturer's data for involved devices.
- H. Combination Circuit Breakers and Ground Fault Circuit Interrupters: UL 943 "Ground Fault Circuit Interrupters," arranged for sensing and tripping for ground fault current in addition to overcurrent and short-circuit current. Provide features as follows:
 - 1. Match features and module size of panelboard breakers and provide clear identification of ground fault trip function.
 - 2. Trip Setting for Ground Fault: 4 to 6 milliamperes, listed and labeled as a class A, type 1 device.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Independently Mounted OCPDs: Locate as indicated and install in accordance with manufacturer's written installation instructions.
- B. OCPDs in distribution equipment shall be factory installed.

3.2 IDENTIFICATION

- A. Identify components in accordance with Section 260195 - Electrical Identification.

3.3 CONNECTIONS

- A. Check connectors, terminals, bus joints, and mountings for tightness. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

3.4 GROUNDING

- A. Provide equipment grounding connections for individually mounted OCPD units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.5 FIELD QUALITY CONTROL

- A. Visual and mechanical inspection: Include the following inspections and related work.
 - 1. Overcurrent-Protective-Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system arrangement and parameters. Where discrepancies are found, test organization shall recommend final protective device ratings and settings. Use accepted revised ratings or settings to make the final system adjustments.
 - 2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current single line diagram.
 - 3. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
 - 4. Check tightness of electrical connections of OCPDs with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
 - 5. Clean OCPDs using manufacturer's approved methods and materials.
 - 6. Verify installation of proper fuse types and ratings in fusible OCPDs.

- B. Electrical Tests: Include the following items performed in accordance with manufacturer's instructions:
 - 1. Insulation resistance test of OCPD conducting parts. Insulation resistance less than 100 megohms is not acceptable.

3.6 CLEANING

- A. Upon completion of installation, inspect OCPDs. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.7 DEMONSTRATION

- A. Training: Arrange and pay for the services of factory-authorized service representatives to demonstrate OCPDs and train Owner's maintenance personnel.

- B. Conduct a minimum of one-half day of training in operation and maintenance as specified under "Instructions to Owner Employees" in the "Project Closeout" Section of these specifications. Include both classroom training and hands-on equipment operation and maintenance procedures.

- C. Schedule training with at least seven days' advance notification.

3.8 COMMISSIONING

- A. Infrared Scanning: After Substantial Completion, but not more than 2 months after Final

Acceptance, perform an infrared scan of OCPDs including their line and load connections, fuses, and fuse clips. Also scan OCPD contact structures where accessible to a portable scanner. Include individual OCPDs and those installed in switchboards, panelboards, and motor control centers.

- B. Follow-up Infrared Scanning: Perform two additional follow-up infrared scans of the same devices: one four months after Substantial Completion, and one 11 months after Substantial Completion.
- C. Instrument: Use an infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
- D. Record of Infrared Scanning: Prepare a certified report identifying all OCPDs checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and rescanning observations after remedial action.

END OF SECTION

SECTION 260477 FUSES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this Section:
 - 1. Section 260010 - Basic Electrical Requirements.
 - 2. Section 260050 - Basic Materials and Methods.

1.2 SUMMARY

- A. This Section includes fuses rated 600 V and below and accessory items. Types of products in this Section include the following:
 - 1. Plug Fuses.
 - 2. Cartridge Fuses.
 - 3. Spare Fuse Cabinet.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:
- B. Product Data for fuses. Include descriptive data and time-current curves for all fuses and let-through current curves for those with current limiting characteristics.
- C. Short Circuit Analysis Coordination Study showing graphically how fuses coordinate selectively with both upstream and downstream components. Perform study under the supervision of a registered professional engineer in accordance with ANSI/IEEE Standard 242-1986, "Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems." Include single line diagram, coordinated time/current characteristics, fuse performance curves, and fault current calculations adequate to demonstrate satisfactory component protection and selective coordination of protective devices.
- D. Shop drawing of spare fuse cabinet showing dimensions and features including storage provision for fuse cartons.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. UL Listing and Labeling: Items provided under this Section shall be listed and labeled by UL.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver spare fuses stored in locked spare fuse cabinet after cabinet has been installed.

1.6 EXTRA MATERIALS

- A. Maintenance Stock, Fuses: For types and ratings required, furnish spare fuses, amounting to one unit for every 5 installed units, but not less than one set of 3 of each kind.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Bussmann Div., Cooper Industries, Inc.
 - 2. Eagle Electric Mfg. Co., Inc.
 - 3. General Electric Co.
 - 4. Gould, Inc.
 - 5. Littelfuse, Inc.

2.2 FUSES, GENERAL

- A. General: Provide fuses of types, classes, and current ratings as shown on Drawings. Voltage ratings shall be consistent with the circuits on which used.

2.3 PLUG FUSES

- A. Standard: Comply with UL 198F "Plug Fuses."
- B. Type: Type S, dual-element, time delay.

2.4 CARTRIDGE FUSES

- A. General: Comply with ANSI/IEEE Standard FU1, "Low Voltage Cartridge Fuses." Provide nonrenewable-cartridge-type fuses except as indicated.
 - 1. Class RK1 and RK5 Dual Element Time Delay Fuses: Comply with UL 198E, "Class R Fuses."

2.5 SPARE FUSE CABINET

- A. Cabinet: Wall-mounted, 18 gage minimum steel unit with full-length, recessed piano-hinged door with key coded cam lock and pull.
- B. Size: Provide for orderly storage of all spare fuses of this project plus 15 percent spare capacity, minimum.
- C. Finish: Gray baked enamel.
- D. Cabinet Door: Bear the legend in stenciled 1-1/2-inch-high letters, "SPARE FUSES."

PART 3 EXECUTION

3.1 APPLICATION OF FUSES

- A. General: Apply fuses as indicated and as follows:
- B. New General Purpose Fusible Switches: 30-600 Amperes: Class RK1, time delay.
- C. Combination Starters: Class RK1, time delay.

3.2 INSTALLATION

- A. Install fuses in fusible devices as indicated.
- B. Install spare fuse cabinet wall mounted where indicated.
- C. Coordination Study: Where coordination study recommends changes in types, classes, features, or ratings of fuses or fusible devices from those indicated, make a written request for instructions. Obtain instructions before ordering fuses recommended to be changed.

END OF SECTION

SECTION 260503 – POLES AND STANDARDS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 16 sections apply to this section:
 - 1. Section 16010 - Basic Electrical Requirements.
 - 2. Section 16050 - Basic Electrical Materials and Methods.

1.2 SUMMARY

- A. Extent, location, and details of electrical poles and standards work are indicated on Drawings and in schedules.
- B. Applications of lighting poles and standards specified in this section include the following:
 - 1. Automobile parking lots.
 - 2. Pedestrian walkways.
 - 3. Building entrances.
- C. Excavation and backfilling for poles, standards, and foundations are specified in Division 2.
- D. Concrete for embedding poles, and for pole foundations and footings is specified in Division 3.
- E. Refer to other Division-16 sections for cables/wires, raceways, transformers, and electrical boxes and fittings work which are required in connection with electrical poles and standards.
- F. Exterior lighting fixtures (luminaires) and brackets which are required in connection with electrical poles and standards are specified in another Division-16 section, "Exterior Lighting Fixtures."

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on electrical poles, standards and hardware; include certified dimension drawings for fabricated poles, standards and mast arms, if any.
- B. Shop Drawings: Submit shop drawings of electrical poles and standards, including mast arms and wire/cable connections which are custom work.
- C. Wiring Diagrams: Submit wiring diagrams for electrical poles and standards showing connections to electrical power panel feeders, switches, dimmers, and controllers. Differentiate between portions of electrical wiring which are manufacturer-installed and portions which are field-installed.
- D. Samples: Submit one complete unit and component for each type of electrical pole and standard specified.

1.4 QUALITY ASSURANCE

- A. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical pole and standard work similar to that required for this project.
- B. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 220 and 250, as applicable to installation, and construction of electrical poles and standards.
- C. UL Compliance: Comply with UL standards, including UL 486A and B, pertaining to electrical poles and standards. Provide lighting components and fittings which are UL-listed and labeled.
- D. NEMA Compliance: Comply with NEMA Stds Pub/No's. LE 2 and TT 1 pertaining to electrical pole and standard units, materials, and installation.
- E. IES Compliance: Comply with applicable requirements of IES RP-8, "Roadway Lighting," and RP-20, "Parking Facilities Lighting."
- F. REA Compliance: Comply with applicable requirements of Rural Electrification Administration (REA) guide specifications for installation of steel pole structures.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver electrical pole and standard products, and fittings in factory-fabricated containers or wrappings, which properly protect products from damage.
- B. Store electrical pole and standard products, and fittings in original cartons in well-

ventilated space protected from moisture, construction traffic and debris.

- C. Handle electrical pole and standard products carefully to prevent breakage, denting and scoring finish. Do not install damaged units or components; replace with new.

1.6 SEQUENCING AND SCHEDULING:

- A. Coordinate with other electrical work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of electrical pole and standard work with other work.
- B. Sequence electrical pole and standard installation work with other work to minimize possibility of damage and soiling during remainder of construction period.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

- A. Acceptable Manufacturers: shall be as scheduled on Drawings, for each respective exterior fixture type.

2.2 ELECTRICAL POLES AND STANDARDS:

- A. Metal Lighting Standards: Provide metal, raceway-type, lighting poles and standards, of sizes and types indicated, comprised of shafts and tenon joints. Equip with grounding connections readily accessible from handhole or transformer base access doors; and construct of the following materials and additional construction features:
 - 1. Material: Extruded aluminum.
 - 2. Configuration: Anchor base type with hand hole and cover where indicated.
- B. Metal Lighting Standard Accessories: Provide accessories for metal lighting standards, including anchor bolts, as recommended by lighting standard manufacturer, of sizes and materials needed to meet erection and loading application requirements.
- C. Metal Poles: Provide extruded aluminum, tapered tubular seamless shaft poles, of sizes and types indicated, with 1/4" bearing plates and ground sleeves for direct embedment. Provide removable step bolts 3/4" diameter and 6" long with threaded steel lugs welded to pole beginning 12" above finish grade. Space step bolts at 15" intervals on alternative sides of pole continuing to the top. Provide pole with adequately sized reinforced handhole complete with matching cover and located on climbing side of pole, 18" above grade level. Weld 1/2" grounding nut on shaft with accessibility from handhole. Design poles to withstand loads developed by 100 MPH wind pressure, as adjusted for height

above ground level, structural shapes and cable/wire loading. Construct poles whose total length is greater than 40 feet in two sections for shipping purposes.

- D. **Metal Pole Accessories:** Provide accessories for metal poles, including crossarms, bolts, lifting eyes, and nuts as recommended by pole manufacturer, of sizes and materials needed to meet erection and loading application requirements.

PART 3 EXECUTION

3.1 EXAMINATION:

- A. Examine areas and conditions under which pole and standard equipment and components are to be installed, and substrate which will support equipment. Notify Contractor in writing of conditions detrimental to proper completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ROADWAY AND PARKING AREA LIGHTING:

- A. Install pole and standard units and products as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NESC and NEMA standards, and with recognized industry practices to ensure that roadway and parking area lighting equipment fulfill requirements.
- B. Utilize belt slings or rope (not chain or cable) to protect finishes when raising and setting finished poles and standards.
- C. Where poles and standards are indicated to be embedded in soil, set to depth required for adequate structural support, but not less than minimum 5'-6" below finish grade.
- D. Set poles and standards plumb. Support adequately during backfilling, or when anchoring them to the foundations.
- E. Provide sufficient space encompassing hand access and cable entrance holes for installation of underground cabling where indicated.
- F. Fasten electrical lighting fixtures and brackets securely to structural supports, including poles/standards; and ensure that installed fixtures are plum and level.
- G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B, and the National Electrical Code.

3.3 GROUNDING:

- A. Provide equipment grounding connections for poles and standards. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounding.

END OF SECTION

SECTION 260512 EXTERIOR LIGHTING FIXTURES

PART 1 GENERAL

1.1 SUMMARY

- A. Extent of exterior lighting fixture work is indicated on Drawings and schedules.
- B. Types of exterior lighting fixtures in this section include LED.
- C. Applications of exterior lighting fixtures required for the project include the following:
 - 1. Outdoor area lighting.
 - 2. Outdoor supplementary lighting.
 - 3. Outdoor security lighting.

1.2 SUBMITTALS

- A. **Product Data:** Submit manufacturer's product data and installation instructions on each type exterior building lighting fixture and component. Data shall include all information necessary to indicate compliance with the contract documents, and shall include, but not be limited to, catalog number, certified photometrics from an independent source, driver information, lamp type, and lamp information.
- B. **Shop Drawings:** Submit fixture shop drawings in booklet form with separate sheet for each fixture, assembled in "luminaire type" alphabetical and/or numerical order, with proposed fixture and accessories clearly indicated on each sheet.
- C. **Wiring Diagrams:** Submit wiring diagrams for exterior lighting fixtures showing connections to electrical power panels, switches, dimmers, controllers, and feeders. Differentiate between portions of wiring which are manufacturer-installed and portions which are field-installed.
- D. **Samples:** Submit one complete operating unit for each type of exterior lighting fixture specified.
- E. **Illumination Data:** Provide isofootcandle (isolux) plot diagram of footcandles on horizontal pavement surface which shows composite values of illuminance projected from the arrangement of light sources from indicated fixture locations and heights. Show on the graphic plots the locations, spacings and heights of luminaires.
- F. **LED fixtures:**
 - 1. Computer generated photometric analysis of proposed DAY 1 (defined as the initial

illuminance values), of the lighting installation.

2. Computer generated photometric analysis of End-of-useful life date of the lighting installation.
3. Provide documentation of the expected useful life including the testing and calculation of useful life and verification of site lighting performance at that life.

1.3 QUALITY ASSURANCE

A. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with exterior lighting fixture work similar to that required for project.

B. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 225, 250, 410, and 501 as applicable to installation, and construction of exterior building lighting fixtures.
2. NEMA Compliance: Comply with applicable requirements of NEMA Stds Pub/No. LE 2 pertaining to lighting equipment.
3. IES Compliance: Comply with IES RP-8, 19, 20 and PB-15 pertaining to exterior, parking, and roadway lighting practices and fixtures.
4. UL Compliance: Comply with requirements of UL standards, including Stds 486A and B, pertaining to exterior lighting fixtures. Provide exterior lighting fixtures and components which are UL-listed and labeled.
5. NFPA Compliance: Comply with applicable requirements of NFPA 780, "Lightning Protection Code," pertaining to installation of exterior lighting fixtures.

C. LED

1. Extruded aluminum driver enclosure with heavy wall die-cast aluminum end caps.
2. Fixture shall be 3G vibration rated, and IP66 rated.
3. Fixture shall utilize Light Squares providing scalable lumen packages, these shall be easily field replaceable with quick connects.
4. 70 CRI, 4000 Kelvin,
5. Proprietary circuit module capable of withstanding 10 kV of transient voltage surge. L90 60,000 hours at 40 degrees C, compliant with IESNA TM-21.
6. 0-10V dimming driver.
7. Site Owner may request standard production model luminaire samples of equal or substitute (including LED package) to product proposed to be installed for inspection.
8. If equal or substitute luminaires are believed to be underperforming in early life, the Site Owner may choose to take field measurements between 2,000 and 3,000 operating hours of the completion of installation to confirm that lighting levels are in accordance with the site-specific photometric requirements in this specification. If uniformity is more that 15% worse or average light levels are more than 15% below the DAY 1 submittal and the luminaire locations in the field are designed,

the luminaire manufacturer must provide additional luminaires to achieve the specified light levels and uniformity. Variance from specified tolerances may be allowed provided prior approval by Owner.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver exterior lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from construction debris and physical damage.
- B. Store exterior lighting fixtures in original wrappings in a clean dry space. Protect from weather, dirt, fumes, water, construction debris, and damage.
- C. Handle exterior lighting fixtures carefully to prevent damage, breaking, and scoring. Do not install damaged fixtures or components; remove units from site and replace with new.

1.5 LED WARRANTY

- A. Standard Warranty – Provide 50,000 hours or greater and:
 - 1. A written five year minimum on-site replacement material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products. Finish warranty must include warranty against failure or substantial deterioration such as blistering, cracking, peeling, chalking, or fading.
 - 2. A written five year replacement material warranty for defective or non-starting LED source assemblies.
 - 3. A written five year replacement material warranty on all power supply units (PSU's) or drivers.
 - 4. Provide a written five year replacement warranty for luminaires producing inadequately-maintained illuminance levels at end of warranty period, as prorated from levels expected at end of useful life. For example, a luminaire expected to produce 70% of initial lumens at 100,000 hours would be expected to last over 11 years (continuous operation), so levels would be expected to be at 87% of initial at end of five-year warranty period. Warranty must cover all light sources (LED package, LED array, or LED module) including, but not limited to the LED die, encapsulate, and phosphor. If the expected useful life of the luminaire system is not maintained, then the manufacturer must replace the light source(s) or luminaire as needed.
 - 5. Warranty period will begin on date of the substantial completion certificate. The supplier will provide the site Owner with appropriate signed and dated warranty certificates at the completion of the project and included into the Record and Information Booklet.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate with other electrical work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of exterior lighting fixtures with other work.
- B. Sequence exterior lighting installation with other work to reduce possibility of damage and soiling of fixtures during remainder of construction period.

1.7 MAINTENANCE

- A. Maintenance Data: Submit maintenance data and parts list for each exterior lighting fixture and accessory; including "trouble-shooting" maintenance guide. Include that data, product data, and shop drawings in a maintenance manual; in accordance with requirements of Division 1.
- B. Extra Stock: Furnish stock or replacement LED boards/cards in the amount of 3 or a minimum of 12 individual LED lamps. Also provide 3 spare drivers. Deliver replacement stock as directed to Owner's storage space, and obtain receipt.

PART 2 PRODUCTS

2.1 BID

- A. Lighting Fixture purchase price package shall be separate from the Lighting Controls price package, they shall NOT be combined as a single bid price package. A single price package will not be accepted. Pricing shall be fair to all agencies.

2.2 FIXTURES

- A. Provide lighting fixtures, of sizes, types and ratings indicated on Drawings; complete with, but not limited to, housings, lamps, lamp holders, reflectors, drivers, starters and wiring. Ship fixtures factory-assembled, with those components required for a complete installation. Design fixtures with concealed hinges and catches, with metal parts grounded as common unit, and so constructed as to dampen driver generated noise.
- B. Provide required dimensional thickness of metal so that all fixtures are rigid, stable and will resist deflection, twisting, warping under normal installation procedures, loading, relamping, etc.
- C. All cast parts, including die-cast members, shall be of uniform quality, free from blow holes, pores, hard spots, shrinkage defects, cracks or other imperfections that affect strength and appearance, or are indicative of inferior metals or alloys.

- D. Reflectors, cones or baffles shall be absolutely free of spinning lines, ripples or any marks or indentations caused by riveting or other assembly techniques. No rivets or hardware shall be visible after installation.
- E. Prior to finishing, all metal surfaces shall be hot cleaned by chemical means and shall receive corrosion inhibiting (phosphating) treatment assuring positive paint adhesion.
- F. Where modified fixtures are specified, fixtures shall be modified as required with lamp sockets positioned to provide desired photometric performance.
- G. Where custom color is indicated on the schedule, a color other than the manufacturer's standard will be required for all parts and components visible after installation. The finish material will be of the same type and process as applied to the standard catalogued item.
- H. All castings and extrusions shall be machined, sanded or similarly treated, and given minimum one coat of baked-on clear methacrylate lacquer, unless a painted finish is specified.
- I. Aluminum surfaces exposed to corrosive atmospheres shall receive a duranodic or polyester powder paint finish for corrosion resistance.
- J. Light fixture trims shall be provided to coordinate with the ceiling material.
- K. Integral wiring devices shall be per Section 260143.
- L. Wiring: Provide electrical wiring within fixture suitable for connecting to branch circuit wiring as NEC Type SF-2 for 277 volt, minimum No. 18 AWG.

2.3 LED

- A. Luminaires must be rated for -40°C to +50°C operation
- B. Correlated Color Temperature (CCT) shall be one Nominal CCT: 5000 K (5028 ± 283).
- C. Duv tolerance of 0.001± 0.006.
- D. Color Rendering Index (CRI): ≥ 65.
- E. Luminaire manufacturer must submit reliability reports indicating that the manufacturer of the LED (chip, diode, or package) has performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows:
 - 1. High Temperature Operating Life (HTOL)
 - 2. Room Temperature Operating Life (RTOL)
 - 3. Low Temperature Operating Life (LTOL)

4. Powered Temperature Cycle (PTMCL)
5. Non-Operating Thermal Shock (TMSK)
6. Mechanical Shock
7. Variable Vibration Frequency
8. Solder Heat Resistance (SHR)

2.4 LED DRIVERS

A. Power supply Units (PSUs) including drivers must meet the following requirements:

1. Must have a minimum efficiency of 85%.
2. Must be rated to operate between -40°C to +50°C.
3. Input Voltage: capable of 120 (±10%) volt, single phase as required by the site.
4. Power supplies can be UL Class I or II output.
5. Operating frequency must be 50/60 Hz.
6. Drivers must have a Power Factor (PF) of: ≤ 0.90 .
7. Drivers must have a Total Harmonic Distortion (THD) of: $\leq 20\%$.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which lighting fixtures are to be installed, and substrate which will support lighting fixtures. Notify Contractor in writing of conditions detrimental to proper completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF EXTERIOR LIGHTING FIXTURES

- A. Install exterior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A-1991 and B, and the National Electrical Code.
- C. Fasten electrical lighting fixtures and brackets securely to indicated structural supports, including poles/standards; and ensure that installed fixtures are plum and level.

- D. Make installation such that the fixture is free of finger marks, flaws, scratches, dents or other imperfections.
- E. Arrangement: Align edges of fixtures with walls or other building elements. Where indicated by dimensions or indicated on Drawings, maintain indicated arrangement.

3.3 GROUNDING

- A. Provide equipment grounding connections for exterior lighting fixtures as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

3.4 FIELD QUALITY CONTROL

- A. Drivers/Power Supplies
- B. Furnish and install drivers for all light fixtures requiring drivers.
- C. Identical fixtures shall be furnished with identical drivers.
- D. Lamps/Light Source
- E. Install lamps in all light fixtures.
- F. All lamps shall be new and unused. If permanent lighting system is used for temporary construction lighting, lamps shall be replaced upon turn over to Owner.
- G. Extra Stock: Furnish stock or replacement LED boards/cards in the amount of 3 or a minimum of 12 individual LED lamps. Also provide 3 spare drivers. Deliver replacement stock as directed to Owner's storage space, and obtain receipt.

3.5 ADJUSTING AND CLEANING

- A. Aim adjustable lighting fixtures and lamps in night test of system. Verify that measured illuminance values comply with isolux plot diagram values.
- B. Clean lighting fixtures of dirt and debris upon completion of installation.
- C. Protect installed fixtures from damage during construction period.

3.6 DEMONSTRATION

- A. Upon completion of installation of exterior lighting fixtures, and associated electrical supply circuitry, apply electrical energy to circuitry to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION

SECTION 260515 INTERIOR LIGHTING FIXTURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 26 Sections apply to this Section:
 - 1. Section 260010 - Basic Electrical Requirements.
 - 2. Section 260050 - Basic Electrical Materials and Methods.

1.2 SUMMARY

- A. Extent, location, and details of interior lighting fixture work are indicated on Drawings and in schedules.
- B. Types of interior lighting fixtures in this section include LED.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions on each type interior building lighting fixture and component. Data shall include, but not be limited to, catalog number, certified photometrics by an independent source, lens/louver type, driver data, lamp socket type, lamp data and any other information necessary to indicate compliance with the contract documents. Driver and lamp product data may not be submitted separately.
- B. Shop Drawings: Submit fixture shop drawings in booklet form with separate sheet for each fixture, assembled in "luminaire type" alphabetical and/or numerical order, with proposed fixture and accessories clearly indicated on each sheet.
- C. Samples: For fixture types and manufacturers indicated on Drawings, samples are generally not required unless specifically requested. If requested, samples shall be provided and will be returned after evaluation.
- D. Maintenance Data: Submit maintenance data and parts list for each interior lighting fixture and accessory; including "trouble-shooting" maintenance guide. Include that data, product data, and shop drawings in a maintenance manual; in accordance with general requirements of Division 1.

1.4 QUALITY ASSURANCE

- A. **Installer's Qualifications:** Firms with at least 3 years of successful installation experience on projects with interior lighting fixture work similar to that required for this project.
- B. **Codes and Standards:**
 - 1. **Electrical Code Compliance:** Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 220, 410, and 510 as applicable to installation, and construction of interior building lighting fixtures.
 - 2. **INEMA Compliance:** Comply with applicable requirements of NEMA Stds Pub/No.'s LE 1 and LE 2 pertaining to lighting equipment.
 - 3. **UL Compliance:** Comply with UL standards, including UL 486A and B, pertaining to interior lighting fixtures. Provide interior lighting fixtures and components which are UL-listed and labeled.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver interior lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from damage.
- B. Store interior lighting fixtures in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, laid flat and blocked off ground.
- C. Handle interior lighting fixtures carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate with other work including ceiling type, wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of interior lighting fixtures with other work.
- B. Sequence interior lighting installation with other work to minimize possibility of damage and soiling during remainder of construction.

PART 2 PRODUCTS

2.1 FIXTURES

- A. **General:**

1. Provide lighting fixtures, of sizes, types and ratings indicated on Drawings; complete with, but not limited to, housings, lamps, lamp holders, reflectors, drivers, starters and wiring. Ship fixtures factory-assembled, with those components required for a complete installation. Design fixtures with concealed hinges and catches, with metal parts grounded as common unit, and so constructed as to dampen driver generated noise.
2. Provide required dimensional thickness of metal so that all fixtures are rigid, stable and will resist deflection, twisting, warping under normal installation procedures, loading, relamping, etc.
3. All cast parts, including die-cast members, shall be of uniform quality, free from blowholes, pores, hard spots, shrinkage defects, cracks or other imperfections that affect strength and appearance, or are indicative of inferior metals or alloys.
4. Reflectors, cones or baffles shall be absolutely free of spinning lines, ripples or any marks or indentations caused by riveting or other assembly techniques. No rivets or hardware shall be visible after installation.
5. Prior to finishing, all metal surfaces shall be hot cleaned by chemical means and shall receive corrosion inhibiting (phosphating) treatment assuring positive paint adhesion.
6. Where modified fixtures are specified, fixtures shall be modified as required with lamp sockets positioned to provide desired photometric performance.
7. Where custom color is indicated on the schedule, a factory applied color other than the manufacturer's standard will be required for all parts and components visible after installation. The finish material will be of the same type and process as applied to the standard catalogued item.
8. Exposed metal surfaces used in interior areas, except chromium-plated parts, shall be given an even coat of high-grade methacrylate lacquer, or transparent epoxy.
9. All castings and extrusions shall be machined, sanded or similarly treated, and given minimum one coat of baked-on clear methacrylate lacquer, unless a painted finish is specified.
10. Aluminum surfaces exposed to corrosive atmospheres shall receive a duranodic or polyester powder paint finish for corrosion resistance.
11. Where a black reveal is specified on any fixture, the reveal must be black from all normal viewing angles.
12. Light fixture trims shall be provided to coordinate with the ceiling material.
13. Integral wiring devices shall be per Section 260143.

B. Wiring: Provide electrical wiring within fixture suitable for connecting to branch circuit wiring as follows:

1. NEC Type AF for 120 volt, minimum No. 18 AWG.
2. NEC Type SF-2 for 277 volt, minimum No. 18 AWG.

2.2 LED FIXTURES

A. LEDS

1. Demonstrate intensity, light output and distribution; spectral characterization of the basis of design.
2. Chromaticity tolerances shall be within 245Kelvin.

2.3 DIFFUSERS

A. Lenses:

1. Extruded 100 percent virgin acrylic material with a minimum weight of ten ounces per square foot.
2. Type 12 - Clear material with 0.156 inch overall thickness with .080 inch penetration comprised of 3/16 inch square based female cones aligned 45 degrees to the length and width of the panel.

PART 3 EXECUTION

3.1 EXAMINATION

- #### A.
- Examine areas and conditions, with Installer present, under which lighting fixtures are to be installed, and substrate for supporting lighting fixtures. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 FIXTURES

A. Coordination

1. Refer to respective reflected ceiling plan for each area. Reflected ceiling plans indicate proper light fixture location only. Coordinate the proper arrangement with all other ceiling mounted devices. Drawings indicate light fixture characteristics (type), quality, quantity, etc. Verify with the ceiling supplier the type and design of actual ceiling installed in each area and coordinate compatible fixture flange.

B. General

1. Store only in a secure, dry, heated location protected from dust, dirt and moisture, in the original cartons.
2. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
3. Provide fixtures and/or fixture outlet boxes with hangers to properly support fixture weight. Submit design of hangers, method of fastening, other than indicated or

specified herein, for review by Architect.

4. All fixtures in one room are the same type, unless otherwise indicated.
5. For all recessed fixtures not prewired, use junction box 12 inches from fixture opening with 4 feet of flexible metal conduit with #12 AWG wire from junction box to fixture.
6. Make installation such that the fixture is free of finger marks, flaws, scratches, dents or other imperfections.
7. Align edges of fixtures with walls or other building elements. Where indicated by dimensions or indicated on Drawings, maintain indicated arrangement.

C. Recessed Mounting

1. Verify ceiling construction and material prior to ordering light fixtures and provide plaster frames for plaster ceilings and flanged frames for drywall ceiling. Provide necessary mounting hardware and accessories to adapt fixture to ceiling construction. Provide gaskets, trims, flanges, etc. as required to prevent light leaks around trim. Where installing "lay-in" type fixtures, provide galvanized supports to the building structure, independent of the ceiling system, at all four corners of the fixture. Each support shall be capable of supporting 100 pounds and each wire shall be a minimum of 12 AWG mild steel. Provide saddle hangers or tie bars attached to runners or between crossbars of ceiling systems as a safety measure. Provide mounting splines or other positive means of maintaining alignment and rigidity. Supporting members shall be surface passivated, and primed or paint-dipped to resist corrosion. Use minimum of two supports independent of the ceiling for each point source type fixture.
2. Stem Mounting: Use self-aligning hangers in canopies to hang fixtures true to vertical. Do not deface ceiling or walls. Locate hangers at intersections of joints or at centers of blocks in rooms with patterned type ceiling materials such as acoustic tile. Use hangers capable of supporting four times fixture weight. Align continuous rows of fixtures maintaining fixtures level without rotation about the longitudinal axis. Rigidly support outlet box independent of ceiling system from building structure. Where obstructions prevent direct support of outlet, provide offset or trapeze hangers of outlet box. Stem shall be supported directly from building structure on maximum 4 foot centers with a minimum of two stems per individual four foot light fixture, and three stems per individual eight foot light fixture
3. Surface Ceiling Mounting: Mount surface fixtures tight to surface without distorting surface. Space fixtures in continuous rows to correspond to ceiling joint intersections. Continuous row fixtures may be fed by a single outlet where fixtures contain approved wireways and suitable wiring is used. Provide hangers for each fixture, each rated to support four times the fixture weight. Provide offset or trapeze hangers where required. Supports shall be provided on a maximum of 4 foot centers with a minimum of two hangers per individual four foot light fixture and three hangers per individual eight foot light fixture. Hang from the corners of fixture. Hangers shall be supported from the building structure and independently from ceiling system or other building services.
4. Fasten fixtures securely to structural supports.

5. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B, and the National Electrical Code.

3.3 DRIVERS/POWER SUPPLIES

- A. Furnish and install drivers for all light fixtures requiring drivers.
- B. Identical fixtures shall be furnished with identical drivers.
- C. Replace any driver which produces an excessive noise (hum) level.

3.4 LAMPS

- A. Install lamps in all light fixtures.
- B. Replace any lamp whose color is determined to be unsatisfactory. Replace all lamps which are found to have failed during the project warranty period.
- C. All lamps shall be new and unused. If permanent lighting system is used for temporary construction lighting, lamps shall be replaced upon turn over to Owner.
- D. Furnish stock or replacement LED boards/cards in the amount of 3 or a minimum of 12 individual LED lamps. Also provide 3 spare drivers. Deliver replacement stock as directed to Owner's storage space, and obtain receipt.

3.5 DIFFUSERS

- A. Furnish required diffusers for all light fixtures.

3.6 ADJUSTING AND CLEANING

- A. Clean interior lighting fixtures of dirt and construction debris upon completion of installation. Clean fingerprints and smudges from lenses, baffles and/or louvers.
- B. Protect installed fixtures from damage during remainder of construction period.
- C. After the installation of lighting is complete, adjust fixtures so requiring at time of darkness.

3.7 GROUNDING

- A. Provide equipment grounding connections for interior lighting fixtures as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

3.8 DEMONSTRATION

- A. Upon completion of installation of interior lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION

SECTION 260526 GROUNDING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes solid grounding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 2 Section "Chain Link Fences and Gates" for fence and gate grounding requirements.
 - 2. Division 10 Section "Flagpoles" for grounding of flagpoles.
 - 3. Division 11 Section "Food Service Equipment" for equipment grounding.
 - 4. Division 14 Sections "Dumbwaiters," "Elevators," "Escalators," and "Materials Handling" for bonding and grounding requirements.
 - 5. Section 260543- Underground Ducts and Manholes.
 - 6. Section 260519 – Low Voltage Wires and Cables (100-600V).

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for ground rods, connectors and connection materials, grounding fittings, molded fusion welding materials and connection diagram.
- C. Field-testing organization certificate, signed by the Contractor, certifying that the organization performing field tests complies with the requirements specified in Quality Assurance below.
- D. Report of field tests and observations certified by the testing organization.

1.3 QUALITY ASSURANCE

- A. Listing and Labeling: Provide products specified in this Section that are listed and labeled. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.

- B. Field-Testing Organization Qualifications: To qualify for acceptance, the independent testing organization must demonstrate, based on evaluation of organization submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.
- C. Electrical Component Standard: Components and installation shall comply with NFPA 70, "National Electrical Code" (NEC).
- D. UL Standard: Comply with UL 467, "Grounding and Bonding Equipment."

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following listed manufacturers:
 - 1. Ground Rods
 - a. Knight Metalcraft
 - b. Nehring
 - c. Or equal as approved by the Professional
 - 2. Molded Fushion Welding Material: Cadweld
 - 3. Clamps/Connectors
 - a. Anixter Bros. Inc.
 - b. Burndy
 - c. Erico Products
 - d. Ideal Industries, Inc.
 - e. O-Z/Gedney Co.
 - f. Thomas & Betts Corp.
 - g. Or equal as approved by the Professional

2.2 GROUNDING AND BONDING PRODUCTS

- A. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.3 WIRE AND CABLE CONDUCTORS

- A. General: Comply with Section 260519 - Wires and Cables. Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

- B. Equipment Grounding Conductor: Green insulated.
- C. Grounding Electrode Conductor: Bare stranded, soft drawn or soft annealed, copper wire.

2.4 MISCELLANEOUS CONDUCTORS

- A. Joints and Connections - Molded fusion welding process using proper mold and the number, size and type cartridge for the joint or connection. Water-pipe connection, silicon bronze approved mechanical connector designed for the pipe and cable to be bonded.
- B. Typical Equipment (power or telecom) Room Ground Terminal Bar: Copper 1/4 inch thick by 2-1/2 inch wide by length shown on the drawings, unless otherwise indicated, with two (2) rows of holes on 1-1/2 inch centers for 1/2 inch bolt, to receive cables two (2) directions.

2.5 CONNECTOR PRODUCTS

- A. General: Listed and labeled as grounding connectors for the materials used.
- B. Pressure Connectors: High-conductivity-plated units.
- C. Bolted Clamps: Heavy-duty units listed for the application.
- D. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

2.6 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core; Size: 3/4 inch by 10 feet.
- B. Plate Electrodes: Copper plates, minimum 0.10 inch thick, size as indicated.

PART 3 EXECUTION

3.1 GENERAL

- A. All equipment, whether furnished by this Division or by others, shall be grounded.
- B. Provide building grounding as shown on Drawing Numbers.

- C. Provide ground connection for electric service.
- D. Provide ground connection for telephone service.
- E. All transformer enclosures and secondary neutrals shall be grounded to an approved cold water pipe. Refer to "single line diagram" and standard detail on the Drawings.

3.2 INSTALLATION

- A. Drive ground rods so that the top of each rod is below building footings.
- B. Make fusion welds in strict accordance with supplier's instructions. Clamp cables securely in place, independent of mold. Clean and inspect all welds. Provide corrosion protection in acid soils.
- C. Ground conductors shall be bonded to building steel for all new construction at every other column at its base.
- D. All connections below grade shall be made with exothermic welds.
- E. At least one connection shall be made between the building ground, the electrical service ground for the building, and a cold-water pipe ground larger than one inch trade diameter.
- F. Drive the ground rods to a minimum depth of ten feet, or more if necessary to reach permanent moisture. Ground rods shall be driven at least two feet away from the footing.
- G. Provide a 3/0 AWG copper ground wire connected on building side of the water meter to the metallic water pipe using suitable pipe clamps unless noted otherwise. Also provide a similar bonding jumper around the water meter that will remain in place whether the water meter is in place or not.
- H. Provide, in the same raceway with the associated phase and/or neutral conductors, a green colored equipment ground conductor having the same type insulation and connected as described below.
 - 1. Install a ground conductor in each raceway to augment the circuit formed by the metallic raceway system. Bond the conductor to each box or enclosure in which access is possible. Size conductor as specified, shown or required by Code, whichever is larger. Install a grounding bushing and bonding jumper to the enclosure or contained ground bus for the following: each termination of conduits 1 inch trade size and larger at a switchboard, panelboard, or other enclosure, each location where multiple ring knockouts are damaged during conduit installation, each location where conduits are stubbed up into floor mounted enclosures; each conduit termination at a painted enclosure where paint is not removed before installation of raceway and each feeder.

2. All branch circuits shall be provided with an equipment grounding conductor sized per NEC Table 250-95. This includes all lighting and power branch circuits.
 3. Provide a ground conductor to all light switches, receptacles, motors, light fixtures and all other branch circuit loads.
 4. Install a ground conductor inside all flexible raceways (e.g., flexible steel, liquid tight). Bond the conductor to the enclosure or ground bus in the nearest box or access on either side of the flexible section. Size conductor as specified, indicated, or required by Code, whichever is larger.
 5. Install a ground conductor in all sectional raceways with removable covers for access (e.g., plug-in strips, surface raceway systems, and wireways) unless specified otherwise. Size conductor in accordance with the NEC for the largest phase conductor size installed in raceway, or as indicated. Bond all sections of the raceway to the ground conductors. Connect all receptacle ground terminals in the raceway to the ground conductor, and make other ground connections shown on Drawings.
- I. Grounding cable shall not be buried directly in concrete, but a conduit sleeve shall be provided where cable passes through concrete.
 - J. Where ground conductors are shown on Drawings and for all feeders, the use of the metallic raceway in place of the ground conductor will not be permitted. Where PVC conduit is used, be responsible for installing a code sized ground conductor, whether shown or not.
 - K. Make grounding connections electrically ahead of any overcurrent or disconnect device or tap connection such that disconnection of neutral load conductors does not interfere with or remove the system ground connection. Use separate lugs on the transformer neutral terminal for neutral and main grounding jumper when cable is used for transformer connections.
 - L. Install a complete grounding electrode system with interconnecting cables and terminations at the equipment room ground terminal bar.
 - M. Make all connections to the grounding electrode system accessible.
 - N. Install equipment room ground terminal bar in equipment rooms where indicated. Mount bar by anchors and bolts using 1-1/2 inch long segments of 1/2 inch rigid conduit as spacer between bar and wall. Use a minimum of two supports 18 inch on center. Connect all grounding electrode system conductors, system enclosure ground bus, and other indicated electrode systems to the terminal bar.
 - O. Unless indicated otherwise, form the equipment ground circuit with rigid metallic raceways (e.g., EMT, rigid steel conduit) where used. Install a bonding jumper for continuity around all fittings and terminations where the conductive raceway is made non-continuous.

- P. Bond all grounding conductors to boxes or enclosures at each access point. Do not use building steel as equipment grounding path. Use welded ground connections, at least where such are buried in soil, installed below slabs on grade, or embedded in concrete.
- Q. Bond all conductive metallic piping system in each mechanical equipment room as required by NEC 250-80/B. Minimum size of conductors as required by NEC. Locate all connections where access is unrestricted for inspection. Looping of conductor from one system to another is acceptable provided the conductor is without splice.

3.3 TESTS

- A. Verify that the ground resistance of each low voltage service, does not exceed 3 Ohms.

Measure by a suitable ground resistance test set operated in strict accordance with the manufacturer's instructions.

- B. Verify there are no accidental grounds on the service(s) by measuring the resistance between the neutral and ground, with the bonding jumper(s) open.
- C. Submit certified test results of the above prior to final acceptance of the facility.

END OF SECTION

SECTION 260535 EMERGENCY LIGHTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this section:
 - 1. Section 260010 - Basic Electrical Requirements.
 - 2. Section 260050 - Basic Electrical Materials and Methods.
 - 3. Section 260120 - Low Voltage Wires and Cables.
 - 4. Section 260515 - Interior Lighting Fixtures, for regular fixtures that may be connected to emergency circuits to provide emergency lighting.

1.2 SUMMARY

- A. This Section includes exit fixtures with integral emergency battery backup.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of emergency lighting unit specified. Assemble in booklet form with separate sheet for each fixture, arranged in unit "type," alphabetical, and/or numerical order, with proposed fixture and accessories clearly indicated on each sheet.
- C. Samples of specific individual products for approval where indicated.
- D. Maintenance data for units specified, for inclusion in Operating and Maintenance Manual specified in Division 1 and in Section 16050 - Basic Electrical Requirements. Submit complete manual material concurrently with system submittal and updated final versions of manuals with closeout procedures specified in Division 1 Section "Project Closeout."
- E. Installation instructions written by manufacturers for all specified products.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA

70 "National Electrical Code."

- B. UL Compliance: Emergency lighting fixtures shall be UL listed and labeled.
- C. NFPA Compliance: Comply with applicable requirements of NFPA 101, "Life Safety Code."
- D. Local Code Compliance: Comply with applicable local codes and regulations for emergency lighting and exit signage including, but not limited to, colors and letter heights for exit signs.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in factory containers. Store in clean, dry space in original container. Protect products from fumes and construction traffic.

1.6 EXTRA MATERIALS

- A. Furnish stock of replacement lamps amounting to 15 percent (but not less than one lamp in each case) of each type and size lamp used in each type unit.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Shall be as scheduled on Drawings, for each respective emergency lighting fixture type.

2.2 EMERGENCY LIGHT SET, EXIT SIGN

- A. Self-contained, LED exit sign unit with maintenance-free nickel-cadmium battery, universal mounting.
- B. Lamps: LED
- C. Style, shape, trim, material, finish, and arrangement of housing as indicated.
- D. Faceplate: as indicated on drawings.
- E. Mounting provisions shall suit individual installation conditions.
- F. Battery: Sealed, wet-cell nickel cadmium type, with 25-year nominal life.

- G. Charger: Minimum 2-rate, fully automatic, solid-state type, with sealed transfer relay.
- H. Finish: Matte white for exposed parts, or as indicated.
- I. Exterior specified fixtures shall be NEMA 4X wet location rated.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Setting and Securing: Set units plumb, square, and level with ceiling and walls and secure in accordance with manufacturer's written instructions and approved shop drawings. Conform to the requirements of NFPA 70.
- B. Mounting heights specified or indicated are to bottom of fixture for suspended or ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures.
- C. Support: Recessed and semi-recessed fixtures may be supported from suspended ceiling support system if the ceiling system support rods or wires are installed at a minimum of four rods or wires per fixture and located not more than 6 inches from fixture corners. For fixtures smaller than the ceiling grid, install a minimum of four rods or wires per fixture and locate at corner of the ceiling grid in which the fixture is located. Do not support fixtures by ceiling acoustical panels. Where fixtures smaller than the ceiling grid are indicated to be centered in the acoustical panel, support fixtures independently with at least two 3/4-inch metal channels spanning and secured to the ceiling tees. Rods or wires for Section "Acoustical Treatment." Install support clips for recessed fixtures, securely fastened to ceiling grid members, at or near each fixture corner.
- D. Lamping and Connection: Lamp units in accordance with manufacturer's instructions. Make external wiring connections required for proper functioning.
- E. Coordinate with other electrical installations as appropriate for proper installation of emergency lighting fixtures.

3.2 ADJUSTING AND CLEANING

- A. Clean emergency units light set upon completion of installation.
- B. Adjust aimable fixtures to provide intended light intensities in egress paths or of equipment.

3.3 GROUNDING

- A. Ground non-current-carrying parts of equipment. Where the copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.
- B. Tighten grounding connections to comply with tightening torques specified in UL Standard 486A.

3.4 FIELD QUALITY CONTROL

- A. Tests: After emergency lighting units have been installed and building circuits have been energized with normal power source, apply and interrupt electrical energy to demonstrate proper operation. Remove and replace malfunctioning units with new units and proceed with retesting. Give the Architect advance notice of dates and times for all field tests. Provide instruments as required to make positive observation of test results. Include the following in tests:
 - 1. Duration of supply.
 - 2. Low battery voltage shutdown.
 - 3. Normal transfer to battery source and retransfer to normal.
 - 4. Low supply voltage transfer.
 - 5. Insulation Resistance Test: Perform as specified in Section 260120- Low Voltage Wires and Cables, both before and after connection of fixtures and equipment.
 - 6. Electrical Continuity Tests: Perform as specified in Section 260120 - Low Voltage Wires and Cables.
 - 7. Lamp Replacement: Prior to tests, install new lamps in emergency lighting units. After testing, place malfunctioning lamps.

END OF SECTION

SECTION 260572 - OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.
 - 1. Short-circuit study input data, including completed computer program input data sheets.

2. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
3. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
4. Revised single-line diagram, reflecting field investigation results and results of short-circuit study.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Short-Circuit Study Specialist.
- B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.6 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Short-Circuit Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Short-Circuit Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the International Electrical Testing Association (NETA) or is a Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

- A. Comply with IEEE 399 and IEEE 551.
- B. Analytical features of fault-current-study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. Executive summary.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
- D. Comments and recommendations for system improvements, where needed.
- E. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 - 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 - 3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- F. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.
- G. Short-Circuit Study Output:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Obtain all data necessary for the conduct of the study.
 1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.
 2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.

- B. Gather and tabulate the following input data to support the short-circuit study. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Obtain electrical power utility impedance at the service.
 3. Power sources and ties.
 4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
 7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
 9. Motor horsepower and NEMA MG 1 code letter designation.
 10. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices as follows:
 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 125 kVA.
 3. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-

switching configurations and alternate operations that could result in maximum fault conditions.

4. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
 - a. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
5. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:
 - a. Electric utility's supply termination point.
 - b. Incoming switchgear.
 - c. Low-voltage switchgear.
 - d. Control panels.
 - e. Standby generators and automatic transfer switches.
 - f. Branch circuit panelboards.
 - g. Disconnect switches.

3.3 ADJUSTING

- A. Make all modifications to equipment as required to accomplish compliance with short-circuit study.

3.4 DEMONSTRATION

- A. Train Owner's operating and maintenance personnel in the use of study results.

END OF SECTION

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.
 - 1. Study results shall be used to determine coordination of series-rated devices.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and equipment evaluation reports.
3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Coordination Study Specialist.
- B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. The following parts from the Protective Device Coordination Study Report:
 - 1) One-line diagram.
 - 2) Protective device coordination study.
 - 3) Time-current coordination curves.
 - b. Power system data.

1.7 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Coordination Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

- C. Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Software Developers:
- B. Comply with IEEE 242 and IEEE 399.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

2.2 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations.

- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."
- F. Protective Device Coordination Study:
 - 1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays:
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.
 - b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, ground).
 - 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
 - c. Fuses: Show current rating, voltage, and class.
- G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - 1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
 - 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
 - 3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
 - 4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Medium-voltage equipment overcurrent relays.
 - c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - f. Cables and conductors damage curves.
 - g. Ground-fault protective devices.

- h. Motor-starting characteristics and motor damage points.
 - i. Generator short-circuit decrement curve and generator damage point.
 - j. The largest feeder circuit breaker in each motor-control center and panelboard.
5. Series rating on equipment allows the application of two series interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Both devices share in the interruption of the fault and selectivity is sacrificed at high fault levels. Maintain selectivity for tripping currents caused by overloads.
 6. Provide adequate time margins between device characteristics such that selective operation is achieved.
 7. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 PROTECTIVE DEVICE COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. The study shall be based on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:
 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 125 kVA.

- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- H. Motor Protection:
 - 1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
 - 2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- J. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.
- K. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:
 - 1. Electric utility's supply termination point.
 - 2. Switchgear.
 - 3. Low-voltage switchgear.

4. Standby generators and automatic transfer switches.
5. Branch circuit panelboards.

M. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.

3.3 LOAD-FLOW AND VOLTAGE-DROP STUDY

- A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:
1. Determine load-flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
 2. Determine load-flow and voltage drop based on 80 percent of the design capacity of the load buses.
 3. Prepare the load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.4 MOTOR-STARTING STUDY

- A. Perform a motor-starting study to analyze the transient effect of the system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze the effects of the motor starting on the power system stability.
- B. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141, and, and voltage sags so as not to affect the operation of other utilization equipment on the system supplying the motor.

3.5 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the overcurrent protective device study.
1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

3. For existing equipment, whether or not relocated obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.
- B. Gather and tabulate the following input data to support coordination study. The list below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Electrical power utility impedance at the service.
 3. Power sources and ties.
 4. Short-circuit current at each system bus, three phase and line-to-ground.
 5. Full-load current of all loads.
 6. Voltage level at each bus.
 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
 12. Maximum demands from service meters.
 13. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
 14. Motor horsepower and NEMA MG 1 code letter designation.
 15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
 16. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.
 17. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

- c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
- d. Generator thermal-damage curve.
- e. Ratings, types, and settings of utility company's overcurrent protective devices.
- f. Special overcurrent protective device settings or types stipulated by utility company.
- g. Time-current-characteristic curves of devices indicated to be coordinated.
- h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.
- k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.6 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
- B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.
- C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.7 DEMONSTRATION

- A. Engage the Coordination Study Specialist to train Owner's maintenance personnel in the following:

1. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.
2. Hand-out and explain the objectives of the coordination study, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting the time-current coordination curves.
3. Adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION

SECTION 260574 - ARC-FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

- A. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- D. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- E. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- F. SCCR: Short-circuit current rating.
- G. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- H. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form:
 - 1. Arc-flash study input data, including completed computer program input data sheets.
 - 2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
 - 3. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Professional for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 - 1. For Power Systems Analysis Software Developer.
 - 2. For Power System Analysis Specialist.
 - 3. For Field Adjusting Agency.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 - 1. Provide maintenance procedures in equipment manuals according to requirements in NFPA 70E.
 - 2. Operation and Maintenance Procedures: Provide maintenance procedures for use by Department's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.

- D. Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.
 - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arc-flash study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- G. Field Adjusting Agency Qualifications:
 - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
 - 2. A member company of NETA.
 - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. ETAP
 - 2. EasyPower
 - 3. SKM Systems Analysis, Inc.
 - 4. Comply with IEEE 1584 and NF PA 70E.
- B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary of study findings.

- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
 - 6. Study Input Data: As described in "Power System Data" Article.
- D. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."
- E. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573 "Coordination Studies."
- F. Arc-Flash Study Output Reports:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2, 3, 5, and 8 cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2, 3, 5, and 8 cycle circuit breakers rated on a total basis.
- G. Incident Energy and Flash Protection Boundary Calculations:
 - 1. Arcing fault magnitude.
 - 2. Protective device clearing time.
 - 3. Duration of arc.
 - 4. Arc-flash boundary.
 - 5. Restricted approach boundary.
 - 6. Limited approach boundary.
 - 7. Working distance.
 - 8. Incident energy.
 - 9. Hazard risk category.
 - 10. Recommendations for arc-flash energy reduction.

11. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
- B. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 1. Location designation.
 2. Nominal voltage.
 3. Protection boundaries.
 - a. Arc-flash boundary.
 - b. Restricted approach boundary.
 - c. Limited approach boundary.
 - d. Arc flash PPE category.
 4. Required minimum arc rating of PPE in Cal/cm squared.
 5. Available incident energy.
 6. Working distance.
 7. Engineering report number, revision number, and issue date.
 8. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis.
 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."
 3. Calculate maximum and minimum contributions of fault-current size.
 4. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
 5. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
 6. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
 7. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.
 8. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.
- C. Include low-voltage equipment locations.
- D. Calculate the limited, restricted, and prohibited approach boundaries for each location.
- E. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
 2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
 3. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:
 4. When the circuit breaker is in a separate enclosure.
 5. When the line terminals of the circuit breaker are separate from the work location.
 6. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the arc-flash hazard analysis.
1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Professional's attention.

2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
- B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:
1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Obtain electrical power utility impedance or available short circuit current at the service.
 3. Power sources and ties.
 4. Short-circuit current at each system bus (three phase and line to ground).
 5. Full-load current of all loads.
 6. Voltage level at each bus.
 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
 9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
 12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
 13. Motor horsepower and NEMA MG 1 code letter designation.
 14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
 15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.4 LABELING

- A. Apply one arc-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each

equipment included in the study. Base arc-flash label data on highest values calculated at each location.

- B. Each piece of equipment listed below shall have an arc-flash label applied to it:
 - 1. Low-voltage switchboard.
 - 2. Switchgear.
 - 3. Panelboard and safety switch.
 - 4. Control panel.

- C. Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.
 - 1. Indicate arc-flash energy.
 - 2. Indicate protection level required.

3.5 APPLICATION OF WARNING LABELS

- A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.6 DEMONSTRATION

- A. Engage Power Systems Analysis Specialist to train Department's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION

SECTION 260671 SURGE PROTECTION DEVICES (SPD)

PART 1 GENERAL

1.1 DESCRIPTION/SCOPE

- A. The Surge Protection Device (SPD) covered under this section includes all service entrance type surge protection devices suitable for use as Type 1 or Type 2 devices per UL1449 3rd Edition, applied to the line or load side of the utility feed inside the facility.
- B. SPD located at Branch Panels and Motor Control Centers.
- C. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to finish and install surge protection devices.

1.2 QUALITY ASSURANCE

- A. UL 1449 3rd Edition (2009 Revision effective 9/29/2009).
- B. UL 1283.
- C. ANSI/IEEE C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- D. ANSI/IEEE C62.45, Guide for Surge Testing for equipment connected to Low-Voltage AC Power Circuits.
- E. IEEE 1100 Emerald Book.
- F. National Fire Protection ASSOCIATION (NFPA 70: NATIONAL ELECTRICAL CODE).

1.3 SUBMITTALS/QUALITY ASSURANCE

- A. Package must include shop drawings complete with all technical information unit dimensions, detailed installation instructions, maintenance manual, recommended replacement parts list and wiring configuration.
- B. Copies of Manufacturer's catalog data, technical information and specifications on equipment proposed for use.
- C. Copies of documentation stating that the Surge Protection Device is listed from a Nationally Recognized Testing Laboratory (NRTL) (UL, ETL, etc) and are tested and multi-listed to UL 1449 and UL 1283.

- D. Copies of actual let through voltage data in the form of oscilloscope results for both ANSI/IEEE C62.41 Category C3 (combination wave) and B3 (Ring wave) tested in accordance with ANSI/IEEE C6245.
- E. Copies of Noise Rejection testing as outlined in NEMA LS1-1992 (R2000) Section 3.11. Noise rejection is to be measured between 50kHz and 100MHz verifying the devices noise attenuation. Must show multiple attenuation levels over a range of frequencies.
- F. Copies of test reports from a recognized independent testing laboratory, capable of producing 80kA surge current waveforms, verifying the suppressor components can survive published surge current rating on a per mode basis using the ANSI/IEEE C62.41 impulse waveform C3 (8 x 20 microsecond, 20kV/10kA). Test data on an individual module is not acceptable.

1.4 PRODUCT WARRANTY:

- A. Warranty on defective material and workmanship shall be for a minimum of 15 years (parts only).
- B. A copy of the warranty is to be sent with submittal. Copy of warranty statement shall clearly establish the terms and conditions to the building/facility owner/operator.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURER:

- A. Current Technology – TG or TransGuard Series (voltage and surge current depending on specific application & location) or approved equal.

2.2 MANUFACTURED UNITS/ ELECTRICAL REQUIREMENTS

- A. Refer to drawing for operating voltage, configuration and surge current capacity per mode for each location.
- B. Declared Maximum Continuous Operating Voltage (MCOV) shall be greater than 115 percent of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL1449 3rd Edition, section 37.7.3. MCOV values claimed based on the component's value or on the 30-minute 115% operational voltage test, section 38 in UL1449 will not be accepted.
- C. Unit shall have not more than 10% deterioration or degradation of the UL1449 3rd Edition Voltage Protection Rating (VPR) due to repeated surges. Unit shall have a monitoring option available to be able to test and determine the percentage of protection available at all times.

- D. Protection Modes SVR (6kV, 500A) and UL1449 3rd Edition VPR (6kV, 3kA) for grounded WYE/delta and High Leg Delta circuits with voltages of (480Y/277), (208Y/120), (600Y/347). 3-Phase, 4 wire circuits, (120/240) split phase shall be as follows and comply with test procedures outlined in UL1449 3rd Edition section 37.6. Values depicted are based on a system Without Disconnect / With Disconnect.

System Voltage	Mode	MCOV	B3 Ringwave	C3 Comb. Wave	UL 1449 Second Edition SVR Rating	UL 1449 Third Edition VPR Rating
120/240 120/208	L-N	150	325/375	650/775	400/400	700/700
	L-G	150	400/450	650/825	500/500	700/700
	N-G	0	350/350	500/500	500/500	900/1000
	L-L	300	400/500	950/1250	700/700	900/1000
277/480	L-N	320	550/600	1125/1225	800/800	900/1000
	L-G	320	850/875	1075/1225	1000/1000	1200/1200
	N-G	0	700/700	900/900	900/900	1200/1500
	L-L	550	650/750	1950/2200	1500/1500	1800/1800

- E. Electrical Noise Filter- each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric noise shall be as follows using the MIL-STD-220A insertion loss test method.
1. 100 kHz at 41 db.
 2. All other frequencies should be 31 db or better.
- F. Each Unit shall provide the following features:
1. Phase Indicator lights, Form C dry contacts, counter and audible alarm.
 2. Field testable while installed.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Each unit shall be installed per Manufacturer’s recommended installation and wiring practices, as show on the drawing supplied.
- B. The UL 1449 Voltage Protection Rating (VPR) shall be permanently affixed to the SPD unit.
- C. The UL 1449 Nominal Discharge Surge Current Rating shall be a minimum of 20Ka.
- D. The SCCR rating of the SPD shall be 80kAIC without requiring an upstream protection device for safe operation.

- E. The unit shall be listed as a Type 1 SPD, suitable for use in both Type 1 and Type 2 locations per UL1449 3rd Edition.
- F. The SPD manufacturer's technician shall perform a system checkout and start-up in the field to assure proper installation, operation and to initiate the warranty of the system. The technician will be required to do the following:
 - 1. Verify voltage clamping levels.
 - 2. Verify N-G connection.
 - 3. Record information to product signature card for each product installed.

END OF SECTION

SECTION 260800 COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Drawings and general provisions of the Subcontract apply to this Section.
- B. Review these documents for coordination with additional requirements and information that apply to work under this Section.
- C. Section Includes:
 - 1. This section specifies the unique responsibilities that are a part of, or are related to the commissioning process for the electrical systems. Electrical systems include those listed in Division 01 Section "General Commissioning Requirements" as being commissioned. All statements are the responsibility of the Subcontractor, unless specifically stated otherwise.
 - 2. Electrical testing specified for systems not listed as formally commissioned are not under the commissioning umbrella and are not governed by this section.
 - 3. Electrical Systems Commissioning consists of static checks of component and system installations and actual testing of equipment conditions and functions.
 - 4. The Commissioning Authority or University will review and approve, prior to use, all test procedures and forms used and will witness a varying fraction of the initial checks and testing performed by the Subcontractor. The Commissioning Authority will review the completed check and test documentation of the Subcontractor of all checks and tests.
 - 5. Electrical testing requirements are found in various sections in Division 01 and in Division 26 (Division 01 Section "General Commissioning Requirements" and this section). It is not the intent of the commissioning process or these specifications to duplicate efforts or to require the Subcontractor to perform any check or test twice. Checks and testing by the Subcontractor are expected to occur once in the normal sequence of installation and checkout, if appropriate coordination has occurred allowing the University and the Commissioning Authority to witness installations and initial testing. Identical electrical checks and testing requirements in both Division 01 and Division 26 are referring to the same event.
 - 6. The test requirements listed in this section do not release the Subcontractor from the obligation to perform all other appropriate, industry standard, manufacturer-recommended or code-required checks and tests.
 - 7. Testing Participants. The work of this section shall be performed by parties identified in the Check and Testing Responsibility Table--a supplement to Division 01 Section "General Commissioning Requirements". Static checks and testing shall be fully documented according to provisions in Division 01 Section "General Commissioning Requirements".

D. Related Sections:

1. Division 01 Section "General Requirements."
2. Division 01 Section "Special Procedures."
3. Division 01 Section "General Commissioning Requirements".

1.2 SUBMITTALS

- A. Submit under provisions of Divisions 01 Section "General Requirements" and "Special Procedures."

1.3 QUALITY ASSURANCE

- A. Qualifications: The CTC (Certified Testing Company) performing the work of this section shall be qualified to test electrical equipment and is a NETA (National Electrical Testing Association)-certified testing agency. The CTC shall not be associated with the manufacturer of equipment or systems under test.
- B. Test Equipment: The Subcontractor shall provide all test equipment necessary to fulfill the checks and testing requirements. Test equipment shall have been calibrated within one year of its use on the project.
- C. Refer to Division 01 Section "General Commissioning Requirements" for additional requirements.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.1 SUBMITTALS

- A. Sixty (60) days before any testing is conducted, submit an overall testing plan and schedule for electrical systems that lists the equipment, modes to be tested, dates of testing and parties conducting the tests. Put these tests into the master construction schedule. Keep this plan and schedule updated.
- B. Additional submittal requirements relative to commissioning are found in this Section and in Division 01 Section "General Commissioning Requirements" and Division 01 Section "General Requirements."

3.2 COMMON RESPONSIBILITIES

- A. The following are responsibilities applicable to all electrical systems being commissioned.
1. The general commissioning requirements and coordination are detailed in Division 01 Section "General Commissioning Requirements" and apply to electrical systems. The Subcontractor shall be familiar with all parts of Division 01 Section "General Commissioning Requirements" and the commissioning plan issued by the Commissioning Authority and shall execute all commissioning responsibilities assigned to them in the Contract Documents.
 2. The work of this Section shall be performed by a CTC (Certified Testing Company, Electrical), by the EC (Electrical Subcontractor), or the MSR (Manufacturer's Service Representative). The Commissioning Authority has some testing responsibilities for some equipment. The specified checks and static tests are conducted by any of the above listed parties, but the tests requiring measurements or special tools or skills are generally conducted only by the CTC. The Check and Testing Responsibility Table, included as a supplement to Division 01 Section "General Commissioning Requirements" provides specific allocation of checklist oversight and testing responsibilities. The CTC, EC, and MSR shall document all checks and testing on check and test procedure forms submitted to and approved by the Commissioning Authority prior to testing.
 3. The Subcontractor shall notify PGCPs ahead of time when commissioning activities not yet performed or not yet scheduled will delay construction. The Subcontractor shall be proactive in seeing that commissioning processes are executed and that the CA has the scheduling information needed to efficiently execute the commissioning process.
 4. The Subcontractor shall respond to notices of issues identified during the commissioning process, making required corrections or clarifications and returning prompt notification to the Commissioning Authority according to the process given in Division 01 Section "General Commissioning Requirements".
 5. When completion of a task or other issue has been identified as holding up any commissioning process, particularly functional testing, the Subcontractor shall, within two days of notification of the issue, notify the Commissioning Authority in writing providing an expected date of completion. The Subcontractor shall notify the Commissioning Authority in writing within one day of completion. It is not the responsibility of the Commissioning Authority to obtain this status information through meeting attendance, asking questions or field observation.
 6. Construction Checklists. The Commissioning Authority or Subcontractor shall develop checklists as noted in the list of commissioned systems in Division 01 Section "General Commissioning Requirements", following the process described in Division 01 Section "General Commissioning Requirements" and in this Section. At a minimum, for a given piece of equipment, checks from the inspection checklists in NETA Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems shall be included in the electrical checklists. The Subcontractor shall execute and document all checks.
 7. Check and testing procedure and startup plan development and execution responsibilities are described in the Check and Testing Responsibility Table in the

supplements to Division 01 Section "General Commissioning Requirements".

8. The Subcontractor shall review design documents, shop drawings and O&M manuals and manufacturer recommended installation and testing procedures of each system installation.
9. The Subcontractor shall monitor installation to ensure the equipment, configuration and quality of construction meets the design requirements, approved submittals and shop drawings.
10. The Subcontractor shall develop test procedures and forms and execute and document testing according to the requirements of this Section, Division 01 Section "General Commissioning Requirements" and other specification sections containing testing requirements.
11. Tests of energized equipment shall be conducted when the equipment is operating at its normal capacity. This may require some tests to be conducted after occupancy.
12. Training and Orientation. The Subcontractor shall follow the facility staff orientation and training requirements as described in Division 01 Section "Demonstration and Training" and other applicable technical sections.
13. Operation And Maintenance (O&M) Manuals. Refer to Division 01 Section "General Commissioning Requirements" and Division 01 Section "General Requirements" for requirements for O&M manuals.

3.3 EQUIPMENT SPECIFIC VERIFICATION AND TESTING REQUIREMENTS

- A. This Part specifies the check and testing requirements for electrical components and systems. From these requirements, the Commissioning Authority or Subcontractor will develop detailed procedures and forms. The general testing process, requirements and test method definitions are described in Division 01 Section "General Commissioning Requirements".

3.4 CHECKS AND TESTS

- A. Checks are intended to begin upon completion of a component or equipment installation. Testing generally occurs later when systems are energized or nearing that point. Beginning system testing before full completion, does not relieve the Subcontractor from fully completing the system as soon as possible, including all construction checklists and may require retesting portions of the system once all components are fully functioning.
- B. Refer to Division 01 Section "General Commissioning Requirements" for specific details on non-conformance issues relating to construction checklists and tests. Refer to Division 01 Section "General Commissioning Requirements", for common requirements of deferred testing and to articles in this Section.
- C. The check and test procedures and record forms shall contain the following:
 1. The Subcontractors executing the checks or tests.

2. A list of the integral components being inspected and tested, equipment tag numbers, manufacturer, model number, pertinent performance information / rating data.
 3. Test equipment used.
 4. Construction checklists associated with the components, if any.
 5. Any special required conditions of the check or test for each procedure.
 6. Items, conditions or functions to be inspected, verified or tested, the checks and testing method given and a place provided with results recorded.
 7. Acceptance criteria or reference by specific table where the acceptance criteria is found.
 8. For each procedure, list the technician performing check or test and company, witnesses of the tests and dates of tests.
 9. Sampling strategies used.
- D. The test procedures for dynamic equipment like lighting controls, emergency generator or fire alarm shall contain more step-by-step procedures with expected responses similar to the sample test provided as a supplement to Division 01 Section "General Commissioning Requirements". The test procedures and forms for more static components like panel boards, switchgear, circuit breakers, transformers, etc., can be more checklist-like in format. For each piece of equipment, checks and test procedures and their documentation record forms may be different documents or combined in the same document, but checks and tests should be grouped.
- E. At the Commissioning Authority's discretion, if large numbers or repeated deficiencies are encountered, the Subcontractor shall test and troubleshoot all remaining systems at issue on their own before commissioning with the Commissioning Authority will resume.
- F. Sampling for Identical Units. When there are a number of identical units, at the Commissioning Authority's discretion, some or all procedures of a test for a piece of equipment or assembly may be omitted when these same tests on other pieces of identical equipment or assemblies were conducted without deficiency.

3.5 EQUIPMENT-SPECIFIC TESTING REQUIREMENTS

- A. The following paragraphs define the testing requirements for each type of system or feature that is a part of the project. The Commissioning Authority shall use this information to develop specific testing procedures for each of the systems to be commissioned. The Subcontractor shall be responsible for support, execution and coordination of these tests as described in the project specifications including intersystem tests and interlocks with systems in Divisions other than Division 26.
- B. The Commissioning Authority and Subcontractor shall coordinate with the project LEED coordinator to verify that LEED requirements for testing electrical systems are included in the tests.

3.6 COMMON TESTING REQUIREMENTS

- A. The following requirements apply to all electrical systems and features that are to be commissioned when referenced below. Tests shall:
1. Verify functionality and compliance with the design intent for each individual sequence module in the sequences of operation. Verify proper operation of all control strategies, energy efficiency and self-diagnostics features by stepping through each sequence and documenting equipment and system performance. Test every step in every written sequence and other significant modes, sequences and operational features not mentioned in written sequences; including startup, normal operation, shutdown, scheduled on and off, unoccupied and manual modes, safeties, alarms, over-rides, lockouts and power failure.
 2. Verify all alarm and high and low limit functions and messages generated on all points with alarm settings.
 3. Verify integrated performance of all components and control system components, including all interlocks and interactions with other equipment and systems.
 4. Verify shut down and restart capabilities both for scheduled and unscheduled events (e.g., power failure recovery and normal scheduled start/stop).
 5. When applicable, demonstrate a full cycle from off to on and no load to full load and then to no load and off.
 6. Verify time of day schedules and setpoints.
 7. Verify all energy saving control strategies.
 8. Verify that monitoring system graphics are representative of the systems and that all points and control elements are in the same location on the graphic as they are in the field.
 9. Provide complete and accurate equipment labeling for the operations and maintenance staff. The equipment labels listed on the drawings and sequences of operation should match the field labels and should be verified as a part of the commissioning process.
 10. Verify operator control of all commandable control system points including proper security level access.
 11. When testing procedures for commissioned equipment are listed in NETA Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems the NETA test procedures shall be part of the testing requirements of this specification. Additional testing procedures may be listed in this specification.
 12. Common Acceptance Criteria
- B. The following common acceptance criteria apply to all mechanical equipment, assemblies and features:
1. For the conditions, sequences and modes tested, the equipment, integral components and related equipment shall respond to varying loads and changing conditions and parameters appropriately as expected, according to the sequences of operation, as specified, according to acceptable operating practice and the manufacturer's performance specifications. Verify that equipment operates within

tolerances specified in: governing codes, acceptance criteria contained in the construction documents, manufacturer's literature and according to good operating practice.

2. Systems shall accomplish their intended function and performance.
3. All safety trips shall require a manual reset to allow a system restart.
4. Resetting a manual safety shall result in a stable, safe, and predictable return to normal operation by the system.
5. Safety circuits and permissive control circuits shall function in all possible combinations of selector switch positions (hand, auto, inverter, bypass, etc.).
6. Other acceptance criteria is given in the equipment testing requirements articles or referenced standards.
7. Additional acceptance criteria will be developed by the Commissioning Authority when detailed test procedures are developed.
8. When testing procedures for commissioned equipment are listed in NETA Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems the NETA performance criteria shall apply.

C. Equipment-Specific Testing Requirements:

1. Scheduled Lighting Controls.
2. Apply the applicable common testing requirements and acceptance criteria.
3. Test Methods. Utilize active testing, and trending when available. If able to trend, trend all zones over a week period and follow the trending guidelines in Division 15 Section "Commissioning of HVAC".
4. Sampling Strategy. Manually test 20 percent of the zones or at least four. If more than 10 percent or two zones fail, test another 10 percent sample. If the second sample fails the Subcontractor shall document retesting on all zones on their own using a Commissioning Authority approved form.

D. Occupancy Sensor Lighting Controls.

1. Apply applicable common testing requirements and acceptance criteria. Test all unit functions, including sensor sensitivity and time-to-OFF functions and ensure that sensor location is proper and won't be tripped inadvertently by other occupants and movements outdoors, etc...
2. Ensure that the sensor is correctly placed and oriented per the specifications and/or construction drawings. If unanticipated obstructions are present, it may be necessary to adjust the sensor location and orientation.
3. Adjust the sensitivity and time delay of the occupancy sensor, and test to ensure it provides appropriate response. For optimal user acceptance, energy savings and lamp life, set the time delay initially for a minimum of 15 minutes (NEMA recommendation).
4. Daylight Harvesting - All furnishings and interior finishes and materials should be installed before calibrating the sensors. Adjust the photosensor to determine the threshold for switching based on detected light level. It may be helpful to calibrate under normal daylight conditions and dusk conditions (it may be possible to close

- window blinds to approximate dusk). Record the calibration adjustments, if possible, and replicate in similar space.
5. Test Methods. Utilize active test methods.
 6. *Time Delay*: The time delay setting indicates how much time it will take to shut off the lights after detecting that the space is unoccupied.
 7. Motion Sensitivity: The occupancy sensor's motion sensitivity level indicates how much movement causes the lights to turn on.
 8. *Entry Test*: If the sensor is used to automatically turn on the lighting, then it should do so within two seconds after the person gets three feet into the space.
 9. *Perimeter Test*: Walk and wave your hand in different places around the room to try to find spots where the sensor is least effective in detecting major and minor motion.
 10. Sampling Strategy. Test 10 percent of the sensors or six, whichever is greater. If more than 10 percent or two sensors fail, test another 10 percent sample. If the second sample fails the Subcontractor shall document retesting on all units on their own using a Commissioning Authority approved form.
 11. Additional Acceptance Criteria. Reasonable sensitivity, no inadvertent trips, lights go off within 15 seconds of design.

E. Emergency Generator System

1. Apply applicable common testing requirements and acceptance criteria.
2. Simulate a utility power outage to verify the essential power system restores power to essential loads.
3. Power to the loads connected to the life safety system within 10 seconds of a utility outage.
4. Test according to NETA 7.22.1 and NFPA 110 5.13 and per Division 01 Section "Special Procedures."
5. Record all data and results.
6. Include the following tests:
 - a. When in enclosed spaces, verify combustion and ventilation air damper functions and pressure drop of exhaust.
 - b. Verify fuel oil system, diesel fuel storage tank, and level and low fuel indication alarms.
 - c. Verify all alarms, meters, and auxiliaries and interlocks to the BAS.
7. Building Test. Under a cold generator condition, provide full utility power interruption under load and cause emergency power service operation. Include all UPS in this test. Load bank the UPS if necessary, during test.
8. Verify all generator functions.
9. Test auto-transfer switch operation under actual voltage drop, per specification Division 26 Section "Automatic Transfer Switch with Bypass-Isolation Feature".
10. Using a power line disturbance monitor, measure the following times: power failure to engine start command, engine start command to engine start (cranking time), engine start to point where generator is at proper volts and frequency and total time from power failure until ATS switches.

11. Verify system reporting & control monitoring point-to-point
12. Verify that each circuit and equipment served by emergency power, does power up. Verify all functions of the Emergency Power Response Matrix.
13. Verify appropriate mechanical system and control system restart functions of all equipment served by the generator.
14. Neutral Bonding - If a 4 pole ATS is used, the neutral should be bonded at the generator or paralleling switchgear. If a 3 pole ATS is used, the neutral should not be bonded at the generator or paralleling switchgear. In both cases the neutral is bonded at the service entrance.
15. Testing of Incoming power and distribution equipment should occur prior to energization of this equipment.
16. The commissioning professional shall request the settings for ATS's and other equipment well in advance of functional performance testing. Verify that the settings are correctly applied in the field.
17. Provide complete and accurate equipment labeling for the operations and maintenance staff. The equipment labels listed on the drawings and sequences of operation should match the field labels and should be verified as a part of the commissioning process.

F. Step Load Tests.

1. Test at 0 percent, 25 percent, 50 percent and 100 percent of full load. Measure voltage and frequency and record all gaged engine conditions. The test shall consist of running the engine-generator while connected to the resistive load bank for one hour, and then shutting down for 30 minutes.
2. Test for multiple generator starts.
3. Verify all operational data and start-up minimum time interval.
4. Verify 2-hour full load run full load bank (building load can serve as part of the load).
5. Verify all generator-running characteristics.
6. Verify battery-charging system.

G. Uninterruptible Power Supply.

1. Apply applicable common testing requirements and acceptance criteria.
2. Test according to NETA 7.22.2 and NFPA 111-2001 5.6.
3. Test the UPS during the Integrated Building Test in the Emergency Generator System test requirements article in this Section.

H. Fire Alarm: Apply applicable common testing requirements and acceptance criteria.

I. NFPA 3: Recommended Practice for Commissioning of Fire Protection and Life Safety Systems and NFPA 4: Standard for Integrated Fire Protection and Life Safety System Testing.

J. Hire a company or person who has qualifications of both fire alarm

commissioning and integrated testing to confirm that the Fire Alarm System interacts properly with other systems.

1. Test the fire alarm and High Sensitivity Smoke Detection systems according to NFPA 110-1999 7-1 through 7-2, and specification Division 28 Sections "High Sensitivity Air Sampling Smoke Detection System" and "MXL Fire Detection & Alarm System".
2. Document all test procedures and results. A fire alarm system printout of the test annunciation record is not sufficient documentation.
3. Verify all fire alarm panel functions, alarms and troubles.
4. Verify all functions in the Fire Alarm Response Matrix, including remote communications.
5. Verify resetting of all equipment affected by an alarm.
6. Sampling Strategy. Verify device functions and annunciations per using the approved sampling rate of the authority having jurisdiction and per LBNL.

END OF SECTION

SECTION 260924 LIGHTING OCCUPANCY SENSORS

PART 1 GENERAL

1.1 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.2 SCOPE

- A. The work covered under this Section shall include furnishing and installing a complete operational occupancy sensor based lighting control system as shown on the Drawings, detailed in the manufacturer's submittal and as herein specified.
- B. Work described in this section shall be coordinated with all applicable plans and specifications, including by not limited to interfacing with microprocessor based Lighting Control Systems, wiring, raceways, boxes and fittings, luminaires, and HAVC systems.

1.3 QUALITY ASSURANCE

- A. Occupancy sensors shall conform to the requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- B. All components shall be listed by Underwriter's Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Products supplied shall be from a single manufacturer that has been continuously involved in manufacturing of occupancy sensors for a minimum of five (5) years. Mixing of manufacturers shall not be allowed.
- D. Products shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rating of less than 1/3 of 1%.
- E. Wall switch products must be capable of withstanding the effects of inrush current. Submittals shall clearly indicate the method used.

1.4 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment,

smoke detectors, fire-suppression system, and partition assemblies.

1.5 SUBMITTALS

- A. Submittals are required in accordance with SECTION 260500 of these specifications. Submittals shall include, but not be limited to the following for review. Submittals not containing all of the information listed below will be rejected. Manufacturers shall substantiate conformance to this specification by providing the necessary documents, performance data and wiring diagrams. Any deviations to the specifications must be clearly stated by letter and submitted.
- B. Submit a scaled building lighting plan (minimum size of 1/16" = 1'-0") clearly marked by the manufacturer showing proper product, location and orientation of each sensor and power pack (switch pack). Plans shall show detection coverage patterns. If necessary for clarity, provide a 1/8" = 1'-0" scaled plan or one plan with coverage areas shown and another plan with the other information shown. Illegible drawings will be rejected.
- C. Submit interconnections diagrams per major subsystem and interfacing with Lighting Control Panels (LCP) (Refer to SECTION 16505), showing proper wiring.
- D. Submit standard catalog literature which includes performance specifications indicating compliance to the specification.
- E. Catalog sheets must clearly state any load restrictions when used with electronic ballasts.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.6 SYSTEM DESCRIPTION

- A. The objective of this specification section is to ensure the proper installation of the occupancy sensor based lighting control system so that lighting is turned off automatically after reasonable time delay when a room or area is vacated by the last person to occupy said room or area.
- B. The occupancy sensor based lighting control shall accommodate all conditions of space utilization and irregular work hours and habits.

1.7 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the Architect/Engineer's final site visitation, and acceptance of each construction

phase, this Contractor shall conduct a complete operation test of each system including each device. The systems shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connection. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.

- B. This Contractor shall perform all tests in the presence of PGCPs Master Electrician. This Contractor shall furnish all personnel for use in the tests.
- C. When the work on the system has been completed and is ready for final review, a visit shall be made by PGCPs Master Electrician at which time the Contractor shall demonstrate that the requirements of the Contract as it applies to this system have been carried out and that the system has been adjusted and operated in accordance herewith.

1.8 TRAINING

- A. Upon completion of the project, the Contractor and manufacturer's factory authorized representative shall provide a minimum of four (4) hours of training to familiarize the Owner with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.

1.9 WARRANTY

- A. Contractor shall warrant all equipment furnished in accordance with this specification to be undamaged, free of defects in materials and workmanship, and in conformance with these specifications. The warranty shall include repair or replacement, and testing without charge to the Owner on all or any parts of equipment which are found to be damaged, defective or non-conforming. There shall be no deductibles applied to such warranty. Satisfactory warranty documents shall be furnished. Refer to SECTION 01740 WARRANTIES AND BONDS.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. The lighting occupancy sensors shall be manufactured by SENSORSWITCH, as listed or equal by GREENGATE (COOPER CONTROLS), HUBBELL, or WATTSTOPPER.
- B. The listing of any manufacturer as "equal" does not imply automatic approval. This Contractor shall ensure submittals made are for sensors and associated equipment which meets or exceeds the specifications included herein.

2.2 LIGHTING OCCUPANCY SENSORS

- A. Occupancy sensors shall consist of, but not be limited to the following:
- B. Sensing technology shall be passive infrared (PIR), MicroPhonics (or ultrasonic), dual technology having both PIR and MicroPhonics (or ultrasonic).
- C. Passive infrared sensors shall provide high immunity to false triggering from RFI (hand-held radios) and EMI (electrical noise in the line). The PIR sensors shall have a multiple segmented Fresnel lens, in multi-tier configuration, with grooves, to eliminate dust and residue build-up.
- D. MicroPhonics shall be used in conjunction with PIR (passive infrared) sensing technology to enable a sensor to provide dual-technology sensing that is completely passive. MicroPhonics shall detect an occupant by detecting leading edge noises typical of human activity while filtering out building noises. The MicroPhonic sensing circuitry shall have automatic gain control to dynamically adapt to the sensor to its environment allowing it to filter out background noise.
- E. Ultrasonic sensors shall be able to adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled spaces. Ultrasonic operating frequency shall be crystal controlled at 32 kHz within + 0.002% tolerance, or 40 kHz within + 0.002% tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.
- F. Dual technology sensors shall consist of PIR and MicroPhonics (or ultrasonic) technologies for occupancy detection.
- G. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.
- H. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
- I. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity for turning lights off, adjustable over a minimum range of 1 to 30 minutes. Settings shall be located on the sensor (not the control unit) and shall be recessed and concealed behind hinged door to limit tampering.
- J. In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch or lighting control panel until the sensor is replaced. This control shall be recessed to prevent tampering.
- K. All sensors shall provide an LED as a visual means of indication at all times to verify

that motion is being detected during both testing and normal operation.

- L. Ceiling mounted room occupancy sensors shall be low voltage dual technology type consisting of passive infrared (PIR) and MicroPhonic (or ultrasonic) technologies with 360° coverage for large classrooms, open office spaces or areas up to 1600 square feet; SENSORSWITCH Model CM PDT 10. Sensors shall operate on 12 to 24 VAC or VDC and NEC Class 2 wiring. Each sensor shall be complete with one (1) power pack or two (2) power packs for rooms requiring two (2) lighting branch circuits. Rooms requiring multiple sensors may only require one (1) power pack for multiple sensors, where shown on the Drawings. Sensors shall also be equipped with an additional isolated relay.
- M. Occupancy sensors shown on the Drawings to be powered from a Lighting Control Panel generally will not require a power pack.
- N. Ceiling mounted (or wall mounted where shown on the Drawings) room occupancy sensors shall be low voltage dual technology type consisting of passive infrared (PIR) and MicroPhonics (or ultrasonic) technologies for directional one-way coverage for classrooms, offices or areas up to 1000 square feet when mounted on a 96-inch- high ceiling; SENSORSWITCH Model WV PDT 16. Sensors shall operate on 12 to 24 VAC or VDC and NEC Class 2 wiring. Each sensor shall be complete with one (1) power pack or two (2) power packs for rooms requiring two (2) lighting branch circuits. Rooms requiring multiple sensors may only require one (1) power pack for multiple sensors, where shown on the Drawings. Sensors shall also be equipped with an additional isolated relay for HVAC control.
- O. Occupancy sensors shown on the Drawings to be powered from a Lighting Control Panel generally will not require a power pack.
- P. Sensitivity Adjustment: Separate for each sensing technology.
- Q. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
- R. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
- S. Extra contact for HVAC control.
- T. Corridor and corridor lobby ceiling mounted occupancy sensors shall be low voltage dual-technology passive infrared (PIR) and MicroPhonics (or ultrasonic) technology type with coverage of approximately 50 linear feet; SENSORSWITCH Model CM PDT 10. Sensors shall operate on 12 to 24 VAC or VDC and NEC Class 2 wiring. Sensors shall be powered from a lighting control panel or power pack and/or as shown on the Drawings. Sensors shall also be equipped with an additional isolated relay.

- U. Detection Coverage (Corridors): Detect occupancy anywhere shown on the drawings with 90 linear feet coverage, 45 feet at each side.
- V. Wall switch occupancy sensors shall be line voltage dual-technology passive infrared (PIR) and MicroPhonic (or ultrasonic) technology type with coverage of approximately 30 to 40 square feet for use in small utility/storage rooms, small toilet rooms, etc. as shown on the Drawings; SENSORSWITCH Model WSX PDT-IV. Sensors shall operate on 120 or 277 volts. Load rating shall be 0 to 800 watts ballast or tungsten at 120 volts and 0 to 1200 watts ballast at 277 volts. Sensor shall use zero-cross circuitry to detect when the sine wave crosses at the “zero-point” so as to minimize wear on the switching contact.
- W. Sensitivity Adjustment: Separate for each sensing technology.
- X. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
- Y. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 400 sq. ft. when mounted on a 48-inch on the wall.
- Z. Provide single or double buttons as shown on the drawings.
- AA. Contractor shall supply stainless steel cover plates, not the plastic cover plates that may be included in the switch packaging. See Specification Section 16130 for type.
- BB. Wall switch occupancy sensors, with dual ON/OFF button switches and dual relays for controlling two lighting loads or circuits, shall be line voltage dual-technology passive infrared (PIR) and MicroPhonic (or ultrasonic) technology type with coverage of approximately 30 to 40 square feet for use in small utility/storage rooms, small toilet rooms, etc. as shown on the Drawings; SENSORSWITCH Model WSX PDT 2P-IV. Sensors shall operate on 120 or 277 volts. Load rating shall be 0 to 800 watts ballast or tungsten at 120 volts and 0 to 1200 watts ballast at 277 volts.
- CC. Contractor shall supply stainless steel cover plates, not the plastic cover plates that may be included in the switch packaging. See Specification Section 16130 for type.

2.3 POWER PACKS AND AUXILIARY RELAY PACKS CONTROL UNITS

- A. Power packs shall accept 120 or 277 volts, be plenum rated, and provide Class 2 power to a minimum of two (2) occupancy sensors. Power packs shall be able to externally mount through a 1/2” knock-out on a standard electrical enclosure (junction box) and be an integrated, self-contained unit consisting internally of an isolated load switching control relay (load rated 20 amperes at 120 or 277 volts) and a transformer to provide

low voltage power; SENSORSWITCH Model PP 20 Power pack shall provide a minimum of 150mA at 15 VDC to drive occupancy sensors and auxiliary relay packs.

- B. Power packs shall use zero-cross circuitry to detect when the sine wave crosses at the “zero-point” so as to minimize wear on the switching contact.
- C. Auxiliary relay packs shall be the same self-contained type unit as the power pack hereinbefore described, except shall not include a transformer; SENSORSWITCH Model SP 20. The auxiliary relay pack shall be used to control another lighting load with a different line voltage than the power pack. Auxiliary relay packs shall be powered from a power pack with 15 VDC.

2.4 ISOLATED RELAY

- A. Sensors hereinbefore described to include an isolated relay shall have the relay be internal with Normally Open, Normally Closed and Common outputs for use with Lighting Control Panels (LCP), HVAC control, and other control options as shown on the Drawings. Sensors utilizing separate components or specially modified units to achieve this function shall not be acceptable.
- B. Corridor and other location occupancy sensors indicated on the Drawings to interface with a Lighting Control Panel (LCP) shall have the isolated relay send a contact closure signal to the Lighting Control System. These sensors shall be powered from the LCP and not by a power pack. Operation of sensors in corridors and other areas where sensors are interfaced with the lighting control system shall operate in a manner such the lighting in the controlled areas is “held-on” during normal school operating hours. After normal school hours, these controlled areas shall respond to the occupancy sensors for lighting control. See the Drawings and details for the sequence of operations via the LCP.

2.5 WIRING

- A. Low voltage wiring between occupancy sensors and power packs shall be three (3) conductor, No. 18 AWG, unshielded, plenum rated with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. A cable that will meet this specification is WEST PENN Cat. No. 25234B.
- B. Low voltage wiring between occupancy sensors and Lighting Control Panels (LCP) shall be three (3) conductor, No. 18 AWG, unshielded, plenum rated with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. A cable that will meet this specification is WEST PENN Cat. No. 25234B.

PART 3 EXECUTION

3.1 INSTALLATION

- A. It shall be the Contractor's responsibility to provide the quantity of occupancy sensors required for complete and proper volumetric coverage to completely cover the controlled areas. Rooms shall have ninety (90) to one hundred (100) percent volumetric coverage to completely cover the controlled areas to accommodate all occupancy habits of single or multiple occupants at any location within the rooms. Proper judgment must be exercised in executing the work so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations, interference of structural components, or furnishings in the rooms or spaces. The locations and quantities of sensors shown on the Drawings are based on coverage patterns of SENSORSWITCH sensors. Sensors of other approved manufacturers may require different quantities of sensors for full coverage of spaces being controlled. The sensors shown on the drawings are diagrammatic and do not necessarily show the exact locations of the sensors. This contractor shall confirm with the occupancy sensors manufacturer the exact quantities of sensors and power packs at time of bid. This Contractor shall provide additional sensors if required to properly and completely cover the respective rooms at no additional cost to the Owner.
- B. Line voltage wall switch type occupancy sensors shall be installed in a suitable wall outlet box in a method recommended by the equipment manufacturer similar to a standard line voltage light switch.
- C. Low voltage occupancy sensors shall be securely mounted to a ceiling or wall mounted junction box in a method recommended by the sensor manufacturer. Ceiling mounted junction boxes shall be supported from the building structure with no less than one (1) 1/4" threaded rod. Sensors shall be wired as detailed on the Drawings and as recommended by the equipment manufacturer.
- D. Power packs shall be located in accessible ceiling spaces and securely mounted to a standard electrical enclosure (junction box) through a standard 1/2" chase nipple. Plastic clips into the junction box shall not be acceptable. Junction box shall be supported from the building structure with no less than one (1) 1/4" threaded rod. All Class 1 wiring shall pass through the chase nipple into the junction box without any exposure of wire leads. Low voltage Class 2 wiring to the sensors shall not be exposed in finished spaces. Power packs shall be wired as detailed on the Drawings and as recommended by the equipment manufacturer.
- E. Supports shall not terminate or be fastened directly to the roof decking except where specifically approved by the Owner.
- F. Wiring:
 - 1. Wiring Method: Comply with Division 16 Section "Conductors and Cables." All low voltage field wiring in finished and unfinished spaces shall be installed by this Contractor in 1/2-inch conduit and/or surface metal raceway as shown

- on the Drawings or hereinbefore specified elsewhere. Conduit fill shall not exceed the conduit space capacity.
2. All low voltage field wiring to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in 1/2-inch conduit.
 3. All low voltage field wiring to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks shall be dedicated to the wiring specified in this specification section.
 4. All low voltage field wiring shall be run at right angles to the building structure.
 5. All low voltage field wiring shall be installed below the roof/floor structural supports (joists, beams, girders, etc.). Wiring installed between the structural supports mentioned above and the roof or floor deck will not be acceptable.
 6. All low voltage field wiring penetrations through new and/or existing walls shall be sleeved. Minimum sleeve size shall be one (1) inch. All sleeves shall be bushed both sides.
 7. All low voltage field wiring for the occupancy sensor systems shall be furnished and installed by this Contractor. All junction box covers shall be stenciled for distinct identification.
 8. All wiring connections shall be made by this Contractor as shown on the Drawings and as recommended by the equipment manufacturer. Splices shall be made only in junction boxes.
 9. All occupancy sensor system wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
 10. Contractor shall test all low voltage cable for integrity and proper operation of the system.
- G. The Contractor shall arrange a pre-installation meeting with the occupancy sensors manufacturer's factory authorized representative, at the project facility to verify proper placement of sensors and installation criteria.

3.2 TESTING

A. Sensor Testing and Adjustment:

1. At the time of installation, the Contractor shall be responsible for testing and adjusting each sensor for proper detection of motion appropriate to room usage. The Contractor shall follow the testing and adjustment procedures as written in the installation instructions for each sensor model. Note: Due to room conditions, it may be necessary for the Contractor to make adjustments, change the location or type of sensor to obtain proper operation and coverage of the system in each room and should therefore make labor and material allowances for such changes and adjustments.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

SECTION 263213 - POWER GENERATOR SETS

PART 1 GENERAL

1.1 SUMMARY:

- A. Extent of power generator set work is indicated by drawings and schedules, and is hereby defined to include, but not by way of limitation, gas engine, electrical generator, engine starting system including batteries, instrument control panel, weather-protective housing, transfer switches, annunciator panel, exhaust silencer and accessories.
- B. Types of generator sets required for the project include the following:
 - 1. Gas engine-driven generator.
 - 2. Concrete and grout for engine-driven generator pads, foundations, frames and bedplates are specified in Division-3 "Concrete" sections.
 - 3. Refer to other Division-26 sections for wires/cables, electrical boxes and fittings, and wiring devices which are required in conjunction with diesel engine-generator work; not work of this section.

1.2 SUBMITTALS:

- A. Product Data: Submit manufacturer's data on gas engine-driven generator sets and components
- B. Shop Drawings: Submit layout drawings of gas engine-driven generator units and accessories including, but not limited to, automatic transfer switches, gas line piping, remote start-stop stations, and instrumentation. In addition, show gas generator set units and their spatial relationship to associated equipment. Allow adequate clearance space for removal of engine generator elements for maintenance purposes.
- C. Wiring Diagrams: Submit wiring diagrams for gas engine-driven generator units showing connections to electrical power panels, feeders, automatic transfer switches, and ancillary equipment. Differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed.
- D. Agreement to Maintain: Prior to time of final acceptance, the Installer shall submit 4 copies of an agreement for continued service and maintenance of gas engine-driven generator sets, for Owner's possible acceptance. Offer terms and conditions for furnishing parts and providing continued testing and servicing, including replacement of materials and equipment, for one-year period with option for renewal of Agreement by Owner.
- E. Certifications: Provide gas engine-driven generator sets certified test record of the

following final production testing:

1. Three-step load pickup (Life Safety and Non-Life Safety)
2. Transient and steady-state governing.
3. Safety shutdown device testing.
4. Voltage regulation.
5. Rated power.
6. Maximum power.

- F. Provide certified test record prior to engine-driven generator set being shipped from factory to project location.

1.3 QUALITY ASSURANCE:

- A. **Manufacturer's Qualifications:** Firms regularly engaged in manufacture of gas engine-driven generator units and ancillary equipment, of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. **Installer's Qualifications:** Firm with at least 3 years of successful installation experience on projects with gas engine-driven generator units similar to that required for this project.
- C. **Codes and Standards:**
1. **Electrical Code Compliance:** Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 517, 700, 701, and 702 pertaining to construction and installation of emergency and standby systems.
 2. **NFPA Compliance:** Comply with applicable requirements of NFPA 37, "Installation and Use of Stationary Combustion Engines and Gas Turbines" and NFPA 101, "Code for Safety to Life from Fire in Buildings and Structures."
 3. **UL Compliance:** Comply with applicable requirements of UL 1008, "Automatic Transfer Switches," UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors."
 4. **ANSI/NEMA Compliance:** Comply with applicable requirements of ANSI/NEMA MG 1, "Motors and Generators," and MG 2, "Safety and Use of Electric Motors and Generators."
 5. **NEMA Compliance:** Comply with applicable requirements of NEMA's Stds Pub No. 250, "Enclosures for Electrical Equipment (1000-Volts Maximum)."
 6. **IEEE Compliance:** Comply with applicable portions of IEEE Std 446, "IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications."

1.4 DELIVERY, STORAGE AND HANDLING:

- A. Deliver gas engine-driven generators properly packaged and mounted on pallets, or skids

- to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for engine-generator and components which protect equipment from damage.
- B. Store gas engine-driven generator equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.
 - C. Handle gas engine-driven generator equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.
 - D. Warranty: Include manufacturer's product warranty, for duration of not less than five years, for replacement of materials and equipment and labor for gas generator systems.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide generator sets of one of the following:
 - 1. Kohler Co.
 - 2. Onan Corp
 - 3. Generac
 - 4. Caterpillar
- B. Gas Generator Sets:
 - 1. General: Except as otherwise indicated, provide manufacturer's standard gas engine-driven generator set and auxiliary equipment as indicated by published product information, and as required for a complete installation.
 - 2. Gas Engine-Driven Generator: Provide packaged electrical power gas engine-driven generator assembly unit as indicated, rated 500 KW, 625 KVA, 563 SKVA (35% voltage drop) at a governed speed of 1800 RPM, and rated 80 percent power factor for continuous operation, 277/480-volt, 3-phase, 4-wire, 60 Hz, 753 amperes at 500 feet altitude, at 85 deg F (29 deg C). Equip generator with 4-cycle, 8-cylinder, 1800 RPM, 223 HP gas engine, and fueled with natural gas. Provide unit-mounted radiator, blower fan, water pump, thermostat, and radiator duct flange capable of cooling engine with up to 0.5 inches water static pressure on fan. Connect engine drive directly to 4-pole revolving-field type single, maintenance-free, bearing generator through semi-flexible steel disk coupling; equip set with associated control equipment to automatically start engine, transfer load to standby power upon failure of normal power source, transfer load back to normal power upon its restoration, and stop engine. Cushion-mount engine-generator on heavy steel base with vibration isolators to reduce possibility of torsional vibration. Provide water-cooled type engine with unit mounted radiator. Equip engine with low-oil pressure, high-water temperature, and automatic overspeed safety

shutdown devices. Equip generator with excitor and voltage regulator to maintain voltage within 2 percent of rated value. Direct-connect generator to fly wheel by semi-flexible steel disk coupling. Provide unit capable of voltage recovery, within regulated range, of 7 seconds following sudden load increase from 0 to 100 percent of rated load, and with voltage dip not to exceed 20 percent upon application of rated load at rated power factor. Construct unit in compliance with applicable standards; and with additional construction features as indicated:

- a. Starting System: Provide engine-generator unit with 12-volt, 3-wire, negative ground, starting system including 12-volt positive engagement solenoid shift-starting motor, batteries and 20-ampere, or greater, automatic battery charging alternator with solid-state voltage regulation.
- b. Instrument Control Panel: Provide engine-generator unit with engine oil-pressure and water-temperature indicators, battery charge-rate ammeter, START - STOP switch for manual operation of unit, reset circuit breaker, static voltage regulator, voltage-adjusting rheostat, voltmeter, ammeter with phase selector switch with an OFF position, and with running time indicator and frequency meters. Select type circuitry of plug-in design capable of quick replacement, and of accepting a plug-in device which allows maintenance to test control panel performance without operating the engine.

2.2 ENGINE-GENERATOR SET ACCESSORIES:

- A. Provide sound proof, rust-resistant weather-protective housing for generator units made of heavy Gage reinforced steel; mate and match to the unit enclosed, which permits proper cooling, and access to both controller and service points. Provide acoustical analysis as required to demonstrate compliance with the sound requirement of a maximum noise at property line that shall be less than 55dBA.
- B. Provide engine block heater, 120V-1800Watt, with thermostatic controls to maintain engine coolant at proper temperature to fulfill start-up requirements of NFPA 99.
- C. Provide 20-light remote annunciator panels with visual and audible alarms to monitor and warn of emergency operating conditions affecting line and generator power sources.
- D. Provide insulated critical-grade exhaust silencers.
- E. All necessary gas line piping and accessories
- F. Provide anchor bolts of galvanized steel, of types and sizes required.
- G. Furnish anchor bolts to concrete formwork Installer with installation drawings and instructions.
- H. Main line circuit breaker.

- I. Batteries and charger.
- J. Remote annunciator.

PART 3 EXECUTION

3.1 EXAMINATION:

- A. Examine areas and conditions under which gas engine-driven generator units are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.2 INSTALLATION OF GAS ENGINE-DRIVEN GENERATOR SETS:

- A. Install gas engine-driven generator units as indicated, in accordance with the equipment manufacturer's written instructions, and with recognized industry practices, to ensure that engine-generator units fulfill requirements. Comply with NFPA and NEMA standards pertaining to installation of engine-generator sets and accessories.
- B. Coordinate with other work, including raceways, electrical boxes and fittings, gas piping and accessories, as necessary to interface installation of engine-generator equipment work with other work.
- C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A, B and the National Electrical Code.
- D. Install units on vibration isolators in accordance with Division-15 section; and comply with manufacturer's indicated method of installation.
- E. Connect gas piping to alternative generator equipment as indicated, and comply with manufacturer's installation instructions.
- F. Align shafts of engine and generator within tolerances recommended by engine-generator unit manufacturer.

3.3 GROUNDING:

- A. Provide equipment grounding connections for gas engine-driven generator units as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounding.

3.4 FIELD QUALITY CONTROL:

A. Start-up Testing:

1. Engage local equipment manufacturer's representative to perform start-up and building load tests upon completion of installation, with the Architect/Engineer in attendance; provide certified test record. Tests are to include the following:
2. Check fuel, lubricating oil, and antifreeze in liquid cooled models for conformity to the manufacturer's recommendations under environmental conditions present.
3. Test prior to cranking engine for proper operation, accessories that normally function while the set is in a standby mode. Accessories include: engine heaters, battery charger, generator strip heater, remote annunciator.
4. Check, during start-up test mode, for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and phase rotation.
5. Test, by means of simulated power outage, automatic start-up by remote-automatic starting, transfer of load, and automatic shut-down. Prior to this test adjust, for proper system coordination, transfer switch timers. Monitor throughout the test, engine temperature, oil pressure, battery charge level, generator voltage, amperes, and frequency.
6. Upon completion of installation demonstrate capability and compliance of system with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Initial testing and retesting to be at no cost to Owner.

3.5 PERSONNEL TRAINING:

- A. Building Operating Personnel Training:** Train Owner's building personnel in procedures for starting-up, testing and operating diesel engine-driven generator sets. In addition, train Owner's personnel in periodic maintenance of batteries.

END OF SECTION

SECTION 263600 - TRANSFER SWITCHES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes transfer switches rated 600 V and under. It includes the following items:
 - 1. Automatic transfer switch. (ATS)
 - 2. Remote annunciation system.
 - 3. Manual transfer switch for temporary/rental generator

1.2 REMOTE ANNUNCIATION SYSTEM

- A. Functional Description: Provide annunciation at a remote annunciator panel of conditions at indicated transfer switches as follows:
- B. Sources available (as defined by actual pick-up and dropout settings of ATS controls).
 - 1. Switch position.
 - 2. Switch in test mode.
 - 3. Switch controls in time-delay sequence.
 - 4. Failure of communication link.
- C. Malfunction of the annunciator or communication link shall not affect any function of the ATS. In the event of a failure of the communication link the ATS shall automatically revert to stand-alone, self-contained operation. No ATS sensing or control function shall depend on the annunciator/control panel for proper operation.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each transfer switch including dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and materials lists.
- C. Wiring diagrams, elementary or schematic, differentiating between manufacturer-installed and field-installed wiring.

- D. Single line diagram of the unit showing connections between the automatic transfer switch, the bypass and isolation switch, the power source and the load, plus interlocking provisions.
- E. Operation and maintenance data for products, for inclusion in Operating and Maintenance Manual specified in Division 1 and in Division 26 Section "Basic Electrical Requirements." Operating and maintenance data shall cover each type of product, including all features and operating sequences, both automatic and manual. List all factory settings of relays and provide relay setting and calibration instructions. Provide spare parts data.
- F. Manufacturer's certificate of compliance to the referenced standards and manufacturer's certification of tested short circuit closing and withstand ratings.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Comply with NFPA 70 "National Electrical Code" for components and installation.
- B. NFPA Compliance: Comply with NFPA Standard 110, "Standard for Emergency and Standby Power Systems."
- C. NEMA Compliance: Comply with NEMA standards: ICS 1, "General Standards for Industrial Control"; ICS 2, "Industrial Control Devices, Controllers and Assemblies"; and ICS 6, "Enclosures for Industrial Controls and Systems."
- D. UL Listing and Labeling: Provided items specified in this section that are listed and labeled by UL for emergency service under UL 1008.
- E. UL Compliance: Comply with UL Standard 1008, "Automatic Transfer Switches," except where requirements of these specifications are stricter.
- F. Single Source Responsibility: Obtain ATs, BPISs, remote annunciators, and remote annunciator and control panels from a single manufacturer who assumes responsibility for all system components furnished.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Automatic Switch Co.

2. Caterpillar, Inc.
3. Kohler Co.
4. Onan Corp.
5. Russelectric, Inc.
6. Zenith Controls, Inc.
7. Eaton

2.2 TRANSFER SWITCH PRODUCTS, GENERAL

- A. General: The following requirements apply to automatic and nonautomatic transfer switch and bypass/isolation switch products:
- B. Ratings: Provide number of poles and current and voltage ratings as indicated. Current ratings for units below 600 amperes shall be identical for all classes or mixtures of loads including 100 percent tungsten filament lamp or 100 percent inductive. Current ratings for units 600 amperes and above shall be for mixtures of loads including up to 30 percent tungsten filament lamp load.
- C. Tested-Fault Current Rating: Exceed the indicated available rms symmetrical fault current at the equipment terminals for closing and withstand ratings based on testing in accordance with UL 1008, conducted at full-rated system voltage and 20 percent power factor. Test each product for withstand duration time for rated short-circuit current correlated with the actual type of circuit protective device indicated for the transfer switch as follows:
 1. Molded-Case Circuit Breakers, 150 Amperes or Less: 1.5 closing and withstand duration cycles.
 2. Molded-Case Circuit Breakers, over 150 Amperes: 3 closing and withstand duration cycles.
 3. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 deg C to 70 deg C. Components shall meet or exceed voltage surge withstand capability when tested in accordance with ANSI Standard C37.90.1, "IEEE Guide for Surge Withstand Capability (SWC) Tests."
 4. Neutral Terminal: Where two- or three-pole switches are indicated, provide fully rated, solid, unswitched neutral terminal except as indicated.
- D. Enclosures: General-purpose NEMA 1 in accordance with UL 508, "Electric Industrial Control Equipment," except as otherwise indicated.
- E. Heater: Within enclosure of units exposed to outdoor-type temperature and humidity conditions. Provide thermostat within enclosure connected to control heater.
- F. Factory Wiring: Train and bundle factory wiring and identify consistently with shop drawings, either by color code or by numbered or lettered wire and cable tape markers at

all terminations. Provide designated terminal blocks for field wiring, and arrange power terminal and field wiring space to be suitable for top, side, or bottom entrance of feeder conductors as indicated. Provide pressure-type terminals suitable for copper or aluminum conductors of sizes indicated.

- G. Electrical operation, where indicated, shall be accomplished by a non-fused momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions. Transfer switches using components of molded case circuit breakers or contactors not designed for continuous duty repetitive switching between active power sources are not acceptable.
- H. Switch action for double-throw-type switches shall be mechanically held in both directions.
- I. Switch Contacts: Silver composition for switching load current with separate arcing contacts where rated 400 amperes and above.
- J. Overcurrent devices shall not be part of transfer switch products.

2.3 AUTOMATIC TRANSFER SWITCHES (ATSs)

- A. Comply with requirements for Level 1 equipment per NFPA 110, "Standard for Emergency and Standby Power Systems."
- B. Features and Characteristics: Include the following:
 - 1. Double throw type switching arrangement, incapable of pauses or intermediate position stops during normal functioning except as indicated.
 - 2. Manual Operator: Capable of transferring the switch to either source position for maintenance purposes. Control circuit shall be disconnected from electrical operator during manual operation.
- C. Accessories: Provide the following ATS accessories:
- D. Close differential voltage sensing on each phase of normal source. Pick-up voltage shall be adjustable from 85 percent to 100 percent of nominal, and dropout shall be adjustable from 75 percent to 98 percent of the pick-up value. Factory set for pick-up at 90 percent and dropout at 85 percent.
- E. Time-delay override of normal source voltage sensing shall delay all transfer and engine start signals. Adjustable 0 to 6 seconds, and factory set at 1 second.
- F. Voltage/frequency lockout relay and sensing of the emergency source shall be provided to prevent premature transfer. Voltage pick-up shall be adjustable from 85 to 100 percent of nominal. Factory set to pick-up at 90 percent of nominal. Pick-up frequency shall be

adjustable from 90 percent to 100 percent of nominal. Factory set to pick-up at 95 percent.

- G. System test switch, momentary type.
- H. Retransfer time delay to normal or preferred power source: adjustable from 0 to 30 minutes and factory set at 30 minutes. Provide automatic defeat of the delay upon loss of voltage or sustained under voltage of the emergency source, provided the normal supply has been restored.
- I. Pilot lights to indicate source to which the load is connected.
- J. Engine starting contacts, one isolated normally closed and one isolated normally open. Contacts shall be gold flashed or plated and rated 10 amperes at 32 V d.c.
- K. Engine Shutdown Contacts: Instantaneous, to initiate shutdown sequence at remote engine-generator controls after retransfer of the load to normal or preferred source.
- L. Unassigned Auxiliary Contacts: Two normally open SPDT contacts for each switch position.
- M. Rating: 10 amperes at 240 V a.c.
- N. Source Available Indicating Lights: A green indicating light to supervise the normal power source with a nameplate engraved "NORMAL SOURCE AVAILABLE," and a red indicating light to supervise the emergency power source with a nameplate engraved "EMERGENCY SOURCE AVAILABLE." Supervision of sources shall be via the transfer switch normal and emergency source sensing circuits, respectively.
- O. Transfer Override Switch: To override automatic retransfer control so the ATS will remain connected to the emergency power source regardless of the condition of the normal source. Provide a pilot light to indicate the override status.

2.4 REMOTE ANNUNCIATOR PANEL

- A. Type: Lamp type with audible signal, silencing switch, and labeled indicating lights, grouped for each transfer switch monitored.
- B. Mounting: Flush modular steel cabinet except as indicated.
- C. Lamp Test: Push-to-test or "lamp test" switch on front panel.

2.5 MANUAL TRANSFER SWITCH

A. Rating

1. The transfer switch shall have equal 3-second withstand; closing and interrupting ratings of amperes as indicated on the drawing, 480 volts, 3-phase.
2. The transfer switch shall be 100% equipment rated for continuous duty.
3. The transfer switch shall be 100% equipment rated for continuous duty as shown on the drawings and shall conform to the applicable requirements of UL 1008 for emergency system total load.
4. The manual transfer switches shall be fully rated for all types of loads, inductive and resistive, without over-sizing, either open or enclosed.

B. Construction: MTS shall be manually operated by a permanently attached manual operator.

C. Wiring/Terminations: Terminal blocks shall conform to NEMA ICS 4. Terminal facilities shall be arranged for entrance of external conductors from the top or bottom of the enclosure. The main transfer switch terminals shall be suitable for the termination of conductors shown on the plans.

D. Enclosure: Each transfer switch shall be provided in a NEMA 1 enclosure suitable for use in environments indicated in the drawings

E. Finish: Enclosures shall be painted with the manufacturer's standard light gray ANSI 61 paint.

F. Accessories: The following accessories shall be provided:

1. Main contact assemblies for NORMAL and EMERGENCY sources shall be equipped with necessary accessories for complete operation at the specified capacity and condition.
2. NORMAL Source Tripped pilot lights
3. EMERGENCY Source Tripped pilot lights
4. Appropriate space heater
5. Other necessary devices for complete installation and operation.

2.6 WIRING

A. Hard-Wired Connections: Conform to Division 26 Section "Wires and Cables" for conductors between transfer switches and remote annunciator panels.

B. Data Circuits: Conform to Division 26 Section "Control/Signal Transmission Media" for links between transfer switches and remote annunciator panels.

2.7 FINISHES

- A. Clean ferrous surfaces to be painted free of oil, grease, welding slag, and spatter, mill scale, corrosion, and dirt.
- B. Paint with rust-inhibiting primer and finish enamel. Apply primer to clean, dry surface immediately after cleaning. Use manufacturer's standard material and procedure except as required to produce a total dry film thickness not less than 2.5 mils. Use finish coat of manufacturer's approved standard color. Provide a finish free from runs, sags, peeling, and other defects.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Wall Mounting of Transfer Switches: Level and anchor the unit to the wall.
- B. Annunciator Panel Mounting: Surface Mount on wall except as indicated.
- C. Identify components in accordance with Division 26 Section "Electrical Identification."

3.2 CONTROL WIRING INSTALLATION

- A. Wiring Between Transfer Switches and Annunciator Panels: Install in metal raceway. Conform to Division 26 Section "Wires and Cables" for hard-wired connections. Conform to Division 26 Section "Control/Signal Transmission Media" for data circuits.

3.3 CONNECTIONS

- A. Check connectors, terminals, bus joints, and mountings for tightness. Tighten field connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

3.4 GROUNDING

- A. Provide equipment grounding connections for transfer switch units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.5 FIELD QUALITY CONTROL

- A. Preliminary Tests: Perform electrical tests as follows:
- B. Measure, with insulation resistance tester, phase-to-phase and phase-to-ground insulation resistance levels to assure requirements are fulfilled. Disconnect control circuits for this test to prevent damage.
- C. Check for electrical continuity of circuits and for short circuits.
- D. Manufacturer's Field Services: Provide services of a factory service representative to assist with demonstrations and field tests.
- E. Field Tests: Energize transfer switches and demonstrate functioning of all devices, components, and sequences. Give seven calendar days' advance notice of the tests, and perform tests in presence of Owner's representative.
- F. Tests shall be coordinated with tests of generator plant and run concurrently with them. Tests shall include the following:
 - 1. Tests for Transfer Switches: Demonstrate each sequence and operational function at least five times.
 - 2. Simulate power failure of normal source.
 - 3. Simulate power failure of emergency source with normal sources available.
 - 4. Simulate low phase to ground voltage for each phase of normal source.
 - 5. Tests for BP/ISs: Include demonstrating each sequence and operational function at least five times.
 - 6. Checking, measuring, and optimizing all adjustable time delays.
- G. Test Failures: Correct deficiencies identified by tests and make ready for retest. Verify equipment meets the specified requirements.
- H. Reports: Maintain a written record of observations and tests. Report defective materials and workmanship and retest corrected defective items. Submit written test reports. Include a record of all adjustable relay settings and measured time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 DEMONSTRATION

- A. Training: Furnish the services of a factory authorized service representative to instruct Owner's personnel in the operation and maintenance of transfer switches and related equipment. Provide a minimum of two hours of instruction scheduled seven days in advance.

3.7 CLEANING

- A. Upon completion of installation, inspect interiors and exteriors of accessible components. Remove dust, dirt, foreign matter, paint splatters and other spots, dirt, and construction debris. Vacuum interior. Touch up scratches and mars of finish to match original finish.

END OF SECTION

SECTION 264113 - LIGHTNING PROTECTION SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes lightning protection systems for buildings, all Roof top units, chimneys etc., and associated structures and includes requirements for lightning protection systems components including, but not limited to, the following:
 - 1. Air terminals.
 - 2. Bonding plates.
 - 3. Conductors.
 - 4. Connectors.
 - 5. Fasteners
 - 6. Grounding plates.
 - 7. Grounding rods.
 - 8. Rod clamps.
 - 9. Splicers.

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified, including roof adhesive where used.
- C. Shop drawings detailing lightning protection system including, but not limited to, air terminal locations, conductor routing, connections and grounding.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer to install lightning protection system. Refer to Division 1, section "Definitions and Standards" for definition of experienced Installer. Upon request, submit evidence of qualifications to the Architect.
- B. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code."
- C. NFPA and UL Compliance: Comply with requirements of NFPA Standard 780, and UL Standard 96 as applicable to lightning protection systems for building projects. The exception will be removal of the ground ring requirements.

- D. ANSI Compliance: Comply with applicable requirements of ANSI Standard C2.

1.4 SEQUENCING AND SCHEDULING

- A. Coordinate installation of lightning protect system with the installation of other building systems and components, including electrical wiring, supporting structures and building materials, and metal components requiring interface with lightning protection systems.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. A-C Lightning Security Inc.
 2. Approved Lightning Protection Co., Inc.
 3. Carl Bajohr Co., Inc.
 4. East Coast Lightning Equipment.
 5. Heary Bros. Lightning Protection.
 6. Independent Protection Co., Inc.
 7. Robbins Lightning Protection Co.
 8. Sewell Manufacturing Co., Inc.
 9. Thompson Lightning Protection, Inc.
 10. West Dodd Lightning Conductor Corp.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Provide lightning protection system materials and components, that comply with manufacturer's standard design, in accordance with published product information. Provide air terminals, bonding plates, conductors, connectors, conductor straps, fasteners, grounding plates, grounding rods, rod clamps, splicers and other components required for a complete system that meets LPI-175, UL 96A or NFPA 780 standards. The exception will be removal of the ground ring requirements.
- B. Type of metal for air terminals and roof cables: aluminum with solid air terminals.
- C. Type of metal for down and ground conductors: copper.
- D. Air Terminals for roof mounting: Provide units with bases especially designed for roof materials.
- E. Ground rods: 3/4-inch minimum diameter by 10-feet long, copper clad steel with minimum 27 percent of the rod weight in the copper cladding.

PART 3 EXECUTION

3.1 INSTALLATION OF LIGHTNING PROTECTION SYSTEMS

- A. Install lightning protection systems as indicated, in accordance with equipment manufacturer's written instructions, and in compliance with applicable installation standards specified above.
- B. Install conductors with direct paths from air terminals to ground connections avoiding sharp bends and narrow loops. Where indicated, run conductors in non-metallic raceway, Schedule 40, minimum.
- C. Install down conductors in a manner to conceal as much as possible. Paint exposed conduit to match building.
- D. Splices and Clamps: Use approved exothermic welded connections for all conductor splices and all connections between conductors and other components.

3.2 CORROSION PROTECTION

- A. Use no combination of materials that may form an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture, unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist that would cause deterioration or corrosion of conductors, use conductors with suitable protective coatings.

3.3 GROUNDING AND BONDING

- A. Provide equipment grounding and bonding connections sufficiently tight to assure permanent and effective grounds and bonds.

3.4 FIELD QUALITY CONTROL

- A. Perform inspections of the lightning protection system installation in accordance with LPI-177, "Inspection Guide for LPI Certified Systems." Provide Architect with one copy of LPI-177 and retain one copy at the project site throughout construction for reference.
- B. Document the inspections on LPI forms LPI-C1-02 and LPI Form 1-R88. Provide one copy of each completed form to the Architect.
- C. Provide advance notice of at least 24 hours to the Architect before concealing lightning protection system work.
- D. UL inspection waved per direction of the owner for this project.

END OF SECTION

SECTION 270000 - GENERAL COMMUNICATIONS PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:

Scope of Work:

1. Intent of Drawings.
2. Pre-Bid Site Visit.
3. Definitions.
4. General Standards of Materials.
5. Products and Substitutions.
6. Applicable Codes.
7. Guarantees and Certificates.
8. Quiet Operation and Vibration Control.
9. Temporary Shutdown of Existing Systems.
10. Coordination.
11. Shop Drawings, Product Data, and Samples.
12. Owner Instruction.

1.3 SCOPE OF WORK

- A. The scope of the work included under Division 27 of the specifications shall include complete systems as shown in the Contract Documents and specified herein. Any work reasonably inferable or required to result in a complete installation or the intended operation and performance of the systems, shall be included in the Base Bid except where there is specific reference to exclusion and incorporation in other quotations.

1.4 INTENT OF DRAWINGS

- A. Provide complete and functional systems for the project. The systems shall conform to the details stated in the specifications and shown on the drawings. Items or work not shown or specified, but required for complete systems, shall be provided and conform with accepted trade practices. The drawings and specifications are presented to define

specific system requirements and serve to expand on the primary contract requirements of providing complete systems. The drawings are diagrammatic and indicate the general arrangement and routing of the systems included in this contractors work.

- B. Do not scale the drawings. Because of the scale of the drawings, it is not possible to indicate offsets, fittings, valves, or similar items which may be required to provide complete operating systems. Carefully investigate conditions affecting the work associated with this project. Check and verify dimensions and existing conditions at the site. Install systems in such a manner that interferences between pipes, conduit, ducts, equipment, architectural and structural features are avoided. Provide items required to meet the project conditions without additional cost to the owner.
 - C. These documents may not explicitly disclose final details required for a complete systems installation; however, contractors shall possess the expertise to include the necessary appointments of complete operating systems.
 - D. Contractors shall be "Experienced" (as defined in Division 1) in this type of construction and realize the extent of the work required.
 - E. BICSI Certification of Workers
 - 1. The contractor will employ a minimum of one Registered Communications Distribution Designer (RCDD) certified by and in good standing with BICSI. This RCDD must be a direct full time employee of the contractor and the contractor will continue a minimum of one RCDD throughout the duration of the project. An RCDD shall remain assigned to the project from start to finish and be available to provide guidance to the installation team.
 - 2. Ortronics/Berk-Tek must be able extend a NetClear 25-year Static, Dynamic and Applications Warranty to the end user once the Telecommunications contractor fulfills all requirements under Ortronics and Berk-Tek OASIS Program. At least 30 percent of the copper installation and termination crew must be certified by Berk-Tek and Ortronics or by BICSI with a Technician Level of training.
- 1.5 PRE-BID SITE VISIT
- A. Bidders shall visit the site and become completely familiar with existing conditions prior to submitting their bid. No extra charges shall be allowed as a result of existing conditions
- 1.6 DEFINITIONS

- A. Specific terminology, as used herein, shall have the following meanings:
1. "Finished Space" ...Space other than mechanical rooms, electrical rooms, furred spaces, pipe chases, unheated spaces immediately below roof, space above ceilings, unexcavated spaces, crawl spaces, tunnels, and interstitial spaces.
 2. "Conditioned"...Spaces directly provided with heating and cooling.
 3. "Unconditioned"...Spaces without heating or cooling including ceiling plenums.
 4. "Indoors"...Located inside the exterior walls and roof of the building.
 5. "Outdoors"...Located outside the exterior walls and roof of the building.

1.7 GENERAL STANDARDS OF MATERIALS

- A. Equipment and materials, unless otherwise noted, shall be new and of first quality, produced by manufacturers who have been regularly engaged in the manufacture of these products for a period of not less than five years.
- B. Equipment of one type shall be the products of one manufacturer; similar items of the same classification shall be identical, including equipment, assemblies, parts and components.
- C. Materials furnished shall be determined safe by a nationally recognized testing organization, such as Underwriters' Laboratories, Inc., or Factory Mutual Engineering Corporation, and materials shall be labeled, certified or listed by such organizations. Where third party certification is required for packaged equipment, the equipment shall bear the appropriate certification label.
- D. With respect to custom made equipment or related installations which are constructed specially for this project, the manufacturer shall certify the safety of same on the basis of test data. The Owner shall be furnished copies of such certificates.

1.8 PRODUCTS AND SUBSTITUTIONS

- A. Where a specific manufacturer's product is specified, the Contract Amount shall be based on that product only. Any substitutions from the specified product shall be offered as a Substitution Request. Refer to Division 1 for requirements. Substitutions shall not be permitted after the bidding phase without a Substitution Request Form included with the bid.

- B. Where several manufacturers' products are specified, the Contract Amount shall be based upon the specified products only. Any substitutions from the specified products shall be offered as a Substitution Request. Refer to Division 1 for requirements. Substitutions shall not be permitted after the bidding phase without a Substitution Request Form included with the bid.
- C. Where only one manufacturer's product is specified, the associated systems have been designed on the basis of that product. Where several manufacturers' products are specified, the associated systems have been designed on the basis of the first-named manufacturer's product. When products other than those used as the basis of design are provided, the contractor shall pay additional costs related to submissions review, redesign, and system and/or structure modifications required by the use of that product.
- D. It is the intent of these specifications that service organizations follow the above substitution procedures.

1.9 APPLICABLE CODES

- A. Materials furnished and work installed shall comply with applicable codes listed in Division 1, with the requirements of the local utility companies, and with the requirements of governmental departments or authorities having jurisdiction.

1.10 GUARANTEES AND CERTIFICATES

- A. Defective equipment, materials or workmanship, including damage to the work provided under other divisions of this contract resulting from same, shall be replaced or repaired at no extra cost to the Owner for the duration of the stipulated guarantee periods.
 - 1. Unless specifically indicated otherwise, the duration of the guarantee period shall be one (1) year following the date of Substantial Completion. Temporary operation of the equipment for temporary conditioning, testing, etc., prior to occupancy will not be considered part of the warranty period.

1.11 QUIET OPERATION AND VIBRATION CONTROL

- A. Equipment and associated items shall operate under conditions of load without sound or vibration deemed objectionable by the Architect. In the case of moving equipment, sound or vibration noticeable outside of the room in which it is installed, or noticeable within the room in which it is installed, shall be deemed objectionable. Sound or vibration deemed

objectionable shall be corrected in an approved manner at no extra cost to the Owner. Vibration control shall be provided by means of approved vibration isolators and installed in accordance with the isolator manufacturer's recommendations.

- B. The sound pressure levels around mechanical and electrical equipment (fans, pumps, motors, etc.) in equipment spaces shall not exceed 85 dBA at any point three (3) feet from the equipment, with all equipment in the room operating. The sound criteria applies to the complete range of each piece of equipment.

1.12 TEMPORARY SHUTDOWN OF EXISTING SYSTEMS

- A. Plan installation of new work and connections to existing work to insure minimum interference with regular operation of existing systems. Some temporary shutdown of existing systems may be required to complete the work.
- B. Submit to the Owner in writing for approval, proposed date schedule, time, and duration of necessary temporary shutdowns of existing systems. Submit schedule at least fifteen (15) calendar days in advance of intended shutdown. Shutdowns shall be made at such times as shall not interfere with regular operation of existing facilities and only after written approval of Owner. The Owner reserves the right to cancel shutdowns at any time prior to the shutdowns. To insure continuous operation, make necessary temporary connections between new and existing work. Bear costs resulting from temporary shutdowns and temporary connections. No additional charges shall be allowed for Owner-canceled shutdowns that must be rescheduled.
- C. Shutdowns must be performed by the Owner. Do not shut-down any system. The Owner reserves the right to require a walk-through of any shutdown prior to the shutdown. Following electrical shutdowns, verify that affected motors are rotating in the proper direction. Bear costs associated with reverse rotated motors.

1.13 COORDINATION

- A. Coordinate and furnish in writing to the Architect information necessary to permit the work to be installed satisfactorily and with the least possible interference or delay.
- B. Coordination drawings shall be prepared as defined in Division 1. No installation of permanent systems shall proceed until the coordination drawings are reviewed by the Architect. No extra charges shall be

allowed for changes required to accommodate installation of systems provided under other divisions of this contract.

- C. Coordination drawings shall be developed from individual system shop drawings and contractor fabrication drawings. Electronic or other reproduced engineering design drawings used as coordination drawings are not acceptable.
- D. When work is installed without proper coordination, changes to this work deemed necessary by the Architect shall be made to correct the conditions without extra cost to the Owner.
- E. The value of the coordination drawings shall be identified as a line item in the Schedule of Values. If the coordination drawings are not submitted as required, their value shall be credited to Owner in accordance with the provisions of Article 7 of the General Conditions. The value of coordination drawings shall be a minimum of two (2.0) percent of this Contract Amount.

1.14 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

- A. Shop drawings, product data, and samples shall be submitted in accordance with the provisions of Division 1.
- B. The following shall be submitted by the Contractor for review:
 - 1. Scale shop drawings showing system components with sizing indicated, including but not limited to:
 - a. equipment locations
 - b. raceways
 - c. insert and sleeve locations
 - d. hangers, anchors and guides
 - e. expansion joints
 - f. access doors
 - 2. Product data for system components and materials (including construction standards).
 - 3. Samples of finishes and trim exposed to view, such as fixture trim, escutcheon plates and similar items.
- C. The value of shop drawings, product data and samples shall be identified as a line item in the Schedule of Values. If the shop drawings, product data and samples are not submitted as required, their value shall be credited to Owner in accordance with the provisions of Article 7 of

the General Conditions. The value of these items shall be a minimum of one (1.0) percent of this Contract Amount.

1.15 OWNER INSTRUCTION

- A. After final tests and adjustments have been completed, furnish the services of qualified personnel to instruct representatives of the Owner in the operation and maintenance procedures for equipment and systems installed as part of this project. Operation and maintenance instructions for major items of equipment shall be directly supervised by the equipment manufacturer's representative. Supply qualified personnel to operate equipment for sufficient length of time as required to meet governing authorities' operation and performance tests and as required to assure that the Owner's representatives are properly qualified to take over operation and maintenance procedures. Minimum instruction period shall be 20 man hours. The instruction period shall be broken into segments at the discretion of the Owner.
1. Notify the Architect, the Owner's representative and equipment manufacturers' representatives, by letter, as to the time and date of operating and maintenance instruction periods approved by the Owner at least one (1) week prior to conducting same.
 2. Forward to the Architect the signatures of all those present for the instruction periods.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 270000

SECTION 270100 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Communications equipment coordination and installation.
 - 2. Sleeves for pathways and cables.
 - 3. Sleeve seals.
 - 4. Grout.
 - 5. Common communications installation requirements.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For sleeve seals.

1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of communications equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.

4. So connecting pathways, cables, wireways, and cable trays, will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR PATHWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Basis-of-Design Product: Subject to compliance with requirements, product by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of pathway or cable.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 POKE THRU DEVICE

- A. Provide large capacity poke-thru device Legrand Wiremold Evolution series model 8ATCPNK-8DP-8B-8ACT6A.
- B. Provide suitable manufacturer device mounting plates to serve jacks and outlets indicated.
- C. Provide blank off plates, Wiremold # 8B.
- D. Provide 8" core drill for each poke-thru device.. Provide x-ray scanning of elevated floor slab for each proposed core drill location to verify core drill area is free from obstructions.
- E. Provide Nickel finish cover assembly. Verify cover assembly is compatible with the flooring for each installation
- F. Provide a 2 gang 2" conduit bottom housing assembly, Wiremold # 22CHA.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable, unless indicated otherwise.

- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Section "Penetration Firestopping."

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 SCANNING OF EXISTING SLABS

- A. The Contractor shall be responsible for selecting and making all penetrations. The Contractor shall provide a scan of each proposed penetration as needed to determine the suitability of proposed penetration.
- B. Contractor shall provide X-ray scanning of all elevated slab areas prior to cutting of slab.
- C. Contractor shall provide high impulse radar scanning of all slab on grade areas prior to cutting of slab.
- D. Contractor shall utilize a professional and qualified concrete cutting and scanning service to perform all work.
- E. Scanning shall be provided at each floor cut.

F. Scanning services shall be performed by:

Maryland Q. C. Laboratories, Inc.
11593 Edmonton Road
Beltsville, Maryland 20705
Tel: 301-931-0590
Fax: 301-931-0632

or approved equal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section "Penetration Firestopping."

END OF SECTION 270100

SECTION 270200 – COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Telecommunications mounting elements.
 - 2. Backboards.
 - 3. Telecommunications equipment floor racks and wall racks
 - 4. Telecommunications pathways and cable trays.
 - 5. Grounding and Bonding.
- B. Related Sections:
 - 1. Section "Data, Voice, and Video Systems" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
- B. BICSI: Building Industry Consulting Service International.
- C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel not exceeding 6 inches (152 mm) in width.
- D. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
- E. LAN: Local area network.
- F. RCDD: Registered Communications Distribution Designer.

- G. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of a bottom without ventilation openings within integral or separate longitudinal side rails.
- H. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 - 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.
- C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Field Inspector: Currently registered by BICSI as Commercial Installer, Level 2 to perform the on-site inspection.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
- D. Grounding: Comply with ANSI-J-STD-607-A.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.7 COORDINATION

- A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
 - 1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
 - 4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 - PRODUCTS

2.1 PATHWAYS

- A. General Requirements: Comply with TIA/EIA-569-A.

- B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.
 - 1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
 - 2. Support brackets with cable tie slots for fastening cable ties to brackets.
 - 3. Lacing bars, spools, J-hooks, and D-rings.
 - 4. Straps and other devices.

- C. Cable Trays:
 - 1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cable Management Solutions, Inc.
 - b. Cablofil Inc.
 - c. Cooper B-Line, Inc.
 - d. Cope - Tyco/Allied Tube & Conduit.
 - e. GS Metals Corp.

 - 2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch (0.012 mm) thick.
 - a. Basket Cable Trays: 12 inches (300 mm) wide and 4 inches (100 mm) deep. Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100 mm).
 - b. Ladder Cable Trays: Nominally 18 inches (455 mm) wide, and a rung spacing of 12 inches (305 mm).
 - c. Channel Cable Trays: One-piece construction, nominally 4 inches (100 mm) wide. Slot spacing shall not exceed 4-1/2 inches (115 mm) o.c.

- D. Conduit and Boxes: Comply with requirements in Division 16.
 - 1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels specified in Section "Rough Carpentry."

- B. Provide 4' w x 8' h x 3/4" fire-retardant-treated plywood backboard, painted white, two feet off the floor to top. Secure backboard with a minimum of eight (8) screws. Plywood backboard shall conform to Product Standard PS1, Grade B-D, with exterior glue and one side finished.

2.3 EQUIPMENT FRAMES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 1. Chatsworth Products, Inc (CPI).
- 2. See Section "Data, Voice and Video Systems" for additional requirements

- B. General Frame Requirements:

- 1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
- 2. Module Dimension: Width compatible with EIA 310 standard, 19-inch (480-mm) panel mounting.
- 3. Finish: Manufacturer's standard, baked-polyester powder coat.
- 4. See Section "Data, Voice and Video Systems" for additional requirements

- C. Floor-Mounted 4 Post Racks: 84" high by 30" deep. 4 post floor frame rack shall be CPI # 50120-X03 or approved equal.

- 1. Double Sided Vertical Cable Management (CPI # 13912-703)
- 2. Horizontal Cable Management (CPI # 30130-719)
- 3. Cage Nuts (CPI # 12637-001)
- 4. Grounding & Bonding lug & kit.
- 5. Power strip.
- 6. See Section "Data, Voice and Video Systems" for additional requirements

- D. Wall Swing Racks: 49" high (27 RMU) by 25" deep. Wall Swing rack shall be CPI # 11807-725 or approved equal.

- 1. Double Sided Vertical Cable Management (CPI # 13912-703)
- 2. Horizontal Cable Management (CPI # 30130-719)
- 3. Cage Nuts (CPI # 12637-001)

4. Grounding & Bonding lug & kit.
5. Power strip.
6. Rack Shelf
7. See Section "Data, Voice and Video Systems" for additional requirements

E. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.4 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Rack mounting.
2. Six 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
3. LED indicator lights for power and protection status.
4. LED indicator lights for reverse polarity and open outlet ground.
5. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
6. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
7. Cord connected with 15-foot (4.5-m) line cord.
8. Rocker-type on-off switch, illuminated when in on position.
9. Peak Single-Impulse Surge Current Rating: 26 kA per phase.
10. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all 3 modes shall be not more than 330 V.
11. Power Strips shall be Horizontal type for wall racks CPI # 12816-712 , and Vertical power strip for floor racks CPI # 12851-723, or approved equal.

2.5 GROUNDING

- A. Comply with requirements in Division 16 Section for grounding conductors and connectors.
- B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
 2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide (6 mm thick by 100 mm wide) with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.
 3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.
- C. Comply with ANSI-J-STD-607-A.

2.6 LABELING

- A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 TELECOMMUNICATIONS ROOMS

- A. Coordinate with Owner's IT and Telephone staff for telecommunications room layout and connections.
- B. Install pathways complying with recommendations in TIA/EIA-569-A.
- C. Comply with NECA 1.
- D. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- E. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.
- F. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 FIRESTOPPING

- A. Comply with requirements in Section "Penetration Firestopping." Comply with TIA/EIA-569-A, Annex A, "Firestopping."
- B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.3 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with ANSI-J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
 - 1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.3 CABLE ROUTING

- A. Wiring for the voice/data/video system shall be installed in cable tray and supported by J hooks, installed four (4') apart. Exposed wiring run in the gymnasium, mechanical rooms, and other rooms where there is no drop ceiling shall be installed in EMT conduit above 10'-0" AFF and in surface metal raceway below 10'-0" AFF. EMT conduit in mechanical rooms may be installed in EMT conduit below 10'-0" AFF.
- B. All voice and data horizontal cables shall not exceed 90 m (295 ft) from the telecommunications outlet in the work area to the horizontal cross connect. The combined length of jumpers, or patch cords and equipment cables in the telecommunications closet and the work area should not exceed 10m (33 feet) total, including 3 m (10 feet) at the station and 6 m (20 feet) at the closet. Every effort will be made to route cables so as not to exceed 90 meters in length. Contractor will identify any cable runs exceeding 90 meters from proposed MDF/IDF location and shall provide solution to meet the 90-meter requirement.
- C. Horizontal pathways shall be installed or selected such that the minimum bend radius of horizontal cables is kept within manufacturer specifications both during and after installation. Cable bends shall be no less than four (4) times the cable outer diameter or 1.00".
- D. In open ceiling cabling, cable supports shall be provided by means that are structurally independent of the suspended ceiling, its framework, or

- supports. These supports shall be spaced no more than 1.2 m (4 feet) apart.
- E. Telecommunications pathways, spaces and metallic cables which run parallel with electric power cables or lighting cables shall be installed with a minimum clearance of 300 mm (12 inches). Communication cables shall not be run parallel with electric power cables for more than 10 m (33 feet) if their separation is less than 300 mm (12 inches).
 - F. Cables routed in a suspended ceiling shall not be draped across the ceiling tiles. Cable supports shall be mounted a minimum of 75 mm (3 in) above the ceiling grid supporting the tiles.
 - G. Cables run exposed above accessible ceilings shall be run in bundles of a size for installation. Bundle by use of cable ties, taking care not to cinch cables. Cable shall be supported from roof structures, joists and other appropriate structural members by means of J hooks. J hooks shall not exceed spacing of four (4) feet. In no case shall any cable be supported from below by contact with the ceiling system. The data, telecommunication and video cabling systems shall be separated into bundles and separated by a minimum of 12". Provide cable ties to secure cables to each "J" hook. Avoid cinching cables.
 - 1. All voice and data telecommunications cable installed above suspended ceilings shall be supported by 2" "J" hooks spaced at a maximum of 48". For support of high density (>50 cables) bulk cable where 48" spacing results in the bowing of cable, the Contractor shall divide bulk cable into smaller parallel streams or decrease the spacing of the "J" hooks sufficiently to adequately support the cable.
 - 2. Where voice and data telecommunication wiring is supported by "J" hooks, wire shall be run neatly bundled with tie wraps. Tie wraps shall be spaced randomly between 6" and 10" apart, 8" on the average. Tie wraps shall be snug, but capable of being easily rotated about the cable bundle so as to secure the cable without binding, deforming or damaging it. Cable deflection shall be less than 5" between "J" hooks.
 - 3. Fiber optic and Category 6 UTP backbone cable shall be run separately from the horizontal distribution cable. This shall be accomplished by running said cable parallel to horizontal distribution cabling supported on the back-side of the "J" hooks used for the horizontal cabling or by supporting the backbone cable separately from the horizontal. In either case, the backbone cabling shall not be tie wrapped together with the horizontal distribution cable.

4. "J" hooks shall be supported directly by the building structure. "J" hooks shall be supported on minimum 3/8" threaded rod anchored to the side hallway walk, or to the slab above. "J" hooks shall **not** be attached to or supported by ceiling supports, piping or piping supports, or duct work or duct work supports.
5. Install cabling below or to the side of the duct work, just above the suspended ceiling. Extend "J" hooks down to support the cabling at that level.

3.4 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Section "Identification for Electrical Systems." Comply with requirements in Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- B. See Section "Data, Voice and Video Systems" for additional identification requirements. See Evaluations for discussion of TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 3 level of administration including optional identification requirements of this standard.
- C. Labels shall be preprinted or computer-printed type.

END OF SECTION 270200

SECTION 270536 - CABLE TRAYS FOR COMMUNICATION SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment and services to completely execute the wire basket system as described in this specification and as shown on the drawings.

B. Wire basket support systems are defined to include, but are not limited to straight sections of continuous wire mesh, field formed horizontal and vertical bends, tees, drop outs, underfloor supports and accessories.

C. Work included in this section: Materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction (AHJ) for the following:

1. Cable runway
2. Cable runway support systems.
3. Cable runway accessories.

D. Related Sections:

1. Division 05 – Metals
 - a. 05 45 16 Electrical Metal Supports
 - b. 05 45 19 Communications Metal Supports
2. Division 26 - Electrical
 - a. 26 05 29 Hangers & Supports for Electrical Systems
 - b. 26 05 36 Cable Trays for Electrical Systems
 - c. 26 05 48 Vibration & Seismic Controls for Electrical Systems
3. Division 27 – Communications
 - a. 27 05 28 29 Hangers & Supports for Communication Systems
 - b. 27 05 28 36 Cable Trays for Communication Systems
 - c. 27 05 48 Vibration & Seismic Controls for Communication Systems
4. Division 28 - Electronic Safety and Security
 - a. 28 05 28 29 Hangers & Supports for Electronic Safety & Security
 - b. 28 05 28 36 Cable Trays for Electronic Safety & Security

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM) International:
1. ASTM A1011 / A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-

2. Strength Low-Alloy with Improved Formability, and Ultra-High Strength ASTM A123 / A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 3. ASTM A510 - Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
 4. ASTM A513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
 5. ASTM A580 – Standard Specification for Stainless Steel Wire
 6. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
 7. ASTM A641 / A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
 8. ASTM A653 / A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 9. ASTM D769 - Standard Specification for Black Synthetic Iron Oxide
- B. National Electrical Manufacturers Association:
1. NEMA FG 1 - Fiberglass Cable Tray Systems.
 2. NEMA VE 1 - Metal Cable Tray Systems.
 3. NEMA VE 2 - Cable Tray Installation Guidelines.
- C. NFPA 70: National Electrical Code (2008)
- D. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises
- E. ANSI/TIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces

1.3 DRAWINGS

A. The drawings, which constitute a part of these specifications, indicate the general route of the wire basket cable tray systems. Data presented on these drawings is as accurate as planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.

B. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.

1.4 QUALITY ASSURANCE

- A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the owner or owner's representative.
- B. Supply all equipment and accessories new and free from defects.
- C. Supply all equipment and accessories in compliance with the applicable standards listed in Part 1.2 of this section and with all applicable national, state and local codes.
- D. All items of a given type shall be the products of the same manufacturer.
- E. Zinc plated wire basket cable tray and Zinc plated cable runway shall be classified by Underwriters Laboratories (UL).
- F. Wire basket cable tray shall be of uniform quality and appearance.
- G. Comply with the National Electrical Code (NEC), as applicable, relating to construction and installation of cable tray and cable channel systems (Article 392, NEC).
- H. Comply with NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance" pertaining to installation of cable tray systems.
- I. Strictly adhere to all Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.

1.5 SUBMITTALS

- A. Submit under provision of section 01 33 00
- B. Submittal Shop Drawings: Submit Shop drawings of all cable tray, runners and accessories including connector assemblies, clamp assemblies, brackets, splice plates, splice bars, grounding clamps and hold-down plates showing accurately scaled components. Indicate wire basket cable tray dimensions, support points, and finishes. Indicate tray type, dimensions, support points, and finishes. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

Vertical and horizontal offsets and transitions.

Clearances for access above and to side of cable trays.

Vertical elevation of cable trays above the floor or bottom of ceiling structure.

Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Product Data: Submit manufacturer's data on wire basket cable tray system including, but not limited to, types, materials, finishes and inside depths. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.

D. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under references. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

E. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

- 1) Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
- 2) Vertical and horizontal offsets and transitions.
- 3) Clearances for access above and to side of cable trays.
- 4) Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

F. Delegated-Design Submittal: For seismic restraints.

- 1) Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
- 2) Design Calculations: Calculate requirements for selecting seismic restraints.
- 3) Detail fabrication, including anchorages and attachments to structure and to supported cable trays.
- 4) SEIMIC PERFORMANCE REQUIREMENTS
 - a. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.

- b. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1) The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
 - 2) Component Importance Factor: 1.5.
- c. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
 - 1) Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces

1.6 CLOSEOUT SUBMITTALS

- A. Submit under provision of section 01 78 00
- B. Project Record Documents: Record actual routing of cable tray and locations of supports.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum 10 years of documented experience, and with service facilities within 100 miles of Project.

1.8 PRE-INSTALLATION MEETINGS

- A. Convene a minimum of 12 week(s) and then again 1 week prior to commencing work of this section.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Ship and store wire basket cable tray system equipment in its original packages and in a clean, dry space to prevent damaging from weather, construction traffic or foreign matter. All handling performed in accordance with manufacturer's recommendations. Provide protective coverings during construction.
- B. Deliver wire basket cable tray systems and components carefully to avoid breakage, bending and scoring finishes. Do not install damaged equipment.
- C. Replace at no expense to Owner, equipment or material damaged during storage or installation as directed by the Architect.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with these specifications, wire basket cable tray systems to be installed shall be as manufactured by the following:

1. Cooper B-Line. 509 West Monroe Street, Highland, IL, 62249, USA. Phone:(618) 654-2184 or email blineus@cooperindustries.com
2. Snake Tray 291 Skip Lane, Bay Shore, New York 11706 800-308-6788 jason@connectivitysolutionsllc.com
3. Or approved equivalent

2.2 WIRE BASKET CABLE TRAY SECTIONS AND COMPONENTS

A. Provide wire basket cable tray of types and sizes indicated with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards. Provide a minimum load support of 75 pounds per linear foot.

B. All straight section longitudinal wires shall be constructed with a continuous top wire safety edge. Safety edge must be kinked and T-welded on all tray sizes.

C. Wire basket cable tray shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All mesh sections must have at least one bottom longitudinal wire along entire length of straight section.

D. Wire basket cable tray sizes shall conform to the following nominal criteria:

1. Straight sections shall be furnished in standard 118.3 inch lengths.
2. Wire diameter shall be 0.196" (5mm) minimum on all mesh sections (minimum size of 4.5mm on stainless steel).
3. Wire tray shall have a 1.5 inch usable loading depth by 4, 6, & 12 inches wide.
4. Wire basket cable tray shall have a 2 inch usable loading depth by 12, 18, & 24 inches wide.
5. Wire basket cable tray shall have a 4 inch usable loading depth by 12, 18, & 24 inches wide.
6. Wire basket cable tray shall have a 6 inch usable loading depth by 12, 18 & 24 inches wide.

E. In order for a system to be approved as an equipment ground conductor (EGC), all splicing assemblies shall be UL Classified or CSA approved as an EGC. When using powder coated wire mesh cable tray as an EGC, the paint must be completely removed at all contact points of splice/ground bolt attachments.

F. Material and Finishes: Material and finish specifications for Carbon Steel Wire are as follows.

1. Electro-Plated Zinc Galvanizing: Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510, Grade 1008 and shall be electro-plated zinc in accordance with ASTM B633, Type III, SC-1. Electroplated zinc products shall NOT be allowed for under-floor applications.

G. All fittings shall be field formed from straight sections in accordance with manufacturer's instructions.

H. Wire basket cable tray supports shall be center support hangers, trapeze hangers or wall brackets as manufactured by Cooper B-Line, Inc. or approved equal.

I. Trapeze hangers or center support hangers shall be supported by 1/4" inch or 3/8" inch diameter rods.

J. Special accessories shall be furnished as required to protect, support and install a wire basket cable tray system.

K. Contractor shall be manufacturer Certified Installer and shall provide & submit documented proof.

L. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.

M. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

N. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.

2.3 RAISED FLOOR WIRE BASKET SECTIONS AND COMPONENTS

A. Provide wire basket of types and sizes indicated; with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additions construction features. Provide a minimum load support of 75 pounds per linear foot.

B. Wire basket shall be made of high strength steel wires and formed into a standard 2 inch by 3-1/2 inch wire mesh pattern with intersecting wires welded together. All mesh sections must have at least one bottom longitudinal wire along entire length of straight section.

C. General: Provide wire basket of types and sizes indicated; with connector assemblies, tool less clips, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

D. Materials and Finishes: Material and finish specifications for each wire basket type are as follows:

1. Stainless Steel: Straight sections and accessories shall be made from AISI Type 304 Stainless Steel.
2. Electroplated zinc products shall NOT be allowed for under-floor applications.

E. In order for a system to be approved as an Equipment Ground Conductor (EGC), all splicing assemblies shall be UL Classified or CSA approved as an EGC. When using powder coated wire mesh cable tray as an EGC, the paint must be completely removed at all contact points of splice/ground bolt attachments.

F. All fittings shall be field formed, from straight sections, in accordance with manufacturer's instructions.

G. Contractor shall be manufacturer Certified Installer and shall provide & submit documented proof.

2.4 WIRE BASKET SUPPORT SYSTEM

A. All straight section longitudinal wires shall be straight (with no bends).

B. Wire basket shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.

C. Wire basket sizes shall conform to the following nominal criteria:

1. Straight sections shall be furnished in standard 24, 48 or 118 inch lengths.
2. Wire basket transition sections shall be flat sections [20] [24] inches wide.
3. Wire basket shall have a 1 inch usable loading depth by [12] inches wide.
4. Wire basket shall have a 2 inch usable loading depth by [2][4][6][8][12][18][20] inches wide.
5. Wire basket shall have a 4 inch usable loading depth by [4][6][8][12][18] [20] inches wide.

6. Wire basket shall have a 6 inch usable loading depth by [6][12][18][20] inches wide.

D. All fittings shall be field formed as needed.

E. All splicing assemblies shall be the bolted type using serrated flange locknuts or using a tool less spring steel fastener hold-down clip at support location. Hardware shall be either pre-galvanized zinc in accordance with ASTM A653, mechanical galvanized zinc in accordance with ASTM B695-or AISI Type 304 Stainless Steel.

F. Raised Floor Wire Basket Supports shall be floor stands that are completely independent of the floor structure requiring no tools for assembly as manufactured by Cooper B-Line, Inc. [or engineer approved equal]. These can be vertically adjustable stands or one piece static stands. Vertically adjustable floor stands shall also have the ability to be stacked on top of each other to allow for multiple tiers of wire basket while still remaining independent of the floor structure.

G. Tool less spring steel fastener hold down clips shall be used to secure the wire basket to the support stand and splice wire basket sections together at this support location.

H. Special accessories shall be furnished as required to protect, support multiple runs of wire basket tray and install a wire basket support system.

2.5 LADDER CABLE TRAYS / CABLE RUNWAY SYSTEMS

A. General: Except as otherwise indicated, provide metal cable runways, of types, classes and sizes indicated with splice connectors, bolts, nuts and washers for connecting units.

B. Runway Types: Material specifications for each runway type are as follows:

1. C-Channel style runway: Runway shall be ladder type with 2 inch stringer height with welded rungs. Stringer siderail shall be rolled steel meeting the minimum chemical and mechanical properties of ASTM A1011 SS Grade 33.
2. Cable runway rungs shall be constructed from ASTM A1011 SS Grade 33 structural steel. Each rung shall be 1/2 inch by 1 inch steel c-channel shape with radiused edges.

3. Runway shall be 12, 18 & 24 inches wide and 60 & 119-1/2 inches long, or as shown on drawings.
4. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1. Provide a minimum load support of 75 pounds per linear foot.

2.6 FITTINGS AND ACCESSORIES

A. General: All fittings, supports, splices, etc. for the cable tray system shall be installed to provide a complete assembly- including fasteners, hardware, and other items required to complete the installation as indicated on the drawings.

1. Smooth radiused 90-degree fittings shall be constructed from ASTM A1011 SS Grade 33 steel. They shall have a 12 inch inside radius and 3 inch straight tangents for secure attachment to straight sections. Rungs shall be spaced a maximum of 6 inches on center when measured along centerline of runway.

B. Furnish manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

C. Covers: Flanged, solid cover.

D. Splicing Assemblies: Bolted type using serrated flange locknuts.

E. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

F. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316

PART 3 EXECUTION

3.1 CABLE TRAY GROUNDING

- a. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- b. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

- c. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- d. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- e. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."
- f. Provide continuity between tray components.
- g. Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.

3.2 INSTALLATION

- A. Install wire basket cable tray in accordance with NEMA VE 2 to ensure that the cable tray equipment complies with the requirements of the NEC, applicable portions of NFPA 70B, and the National Electrical Contractors Association's (NECA) 'Guide to Quality Electrical Installations' pertaining to general electrical installations practices.
- B. All trays should be supported using a minimum of 1/4" All Threaded Rod (ATR).
- C. Special accessories shall be furnished as required to protect, support and install a wire basket cable tray system.
- D. Coordinate wire basket cable tray with other electrical work as necessary to properly interface installation of wire basket cable tray with other work.
- E. Support trays and fasten to structure. Install supports at each connection point, at end of each run, and at other points to maintain spacing between supports of 5 feet maximum.
- F. Install expansion connectors where recommended by manufacturer as indicated on drawings.
- G. Install firestopping in accordance with local and NFPA regulations to sustain ratings when passing wire basket cable tray through fire-rated elements.
- H. Ground and bond metal cable tray in accordance with NFPA 70, National Electrical Code, Article 392: Cable Trays and Motorola R56 standards.
 - 1. Provide continuity between wire basket cable tray components.

2. Make connections to tray using mechanical, compression or exothermic connectors.
 3. Provide 2 AWG bare copper equipment grounding conductor through entire length of tray; bond to each component with a grounding clamp
- I. Provide warning signs at 50 foot centers along wire basket cable tray, located to be visible. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."
- J. Provide sufficient space encompassing wire basket cable tray to permit access for installing and maintaining cables.

3.3 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
 7. Check for improperly sized or installed bonding jumpers.
 8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable

trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

10. Test wire basket support systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. See NFPA 70B, Chapter 18, for testing and test methods.
11. Manufacturer shall provide test reports witnessed by an independent testing laboratory of the "worst case" loading conditions outlined in this specification and performed in accordance with the latest revision of NEMA VE-1.

B. Prepare test and inspection reports.

3.5 PROTECTION

A. Protect installed cable trays and cables.

B. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

C. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

D. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536

SECTION 274100 - AUDIOVISUAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This specification section outlines the minimum requirements and installation methods for the integrated audiovisual (AV) system, hardware, software, licensing, cables, accessories, and acceptance testing.
- B. System refers to the complete and functional assemblage of equipment required to achieve the specified functionality, performance, and design intent.

1.2 REFERENCES

- A. Comply with the following related specification sections:
 - 1. Division 01 – General Requirements.
 - 2. Section 078400 – Firestopping.
 - 3. Division 26 – Electrical.
 - 4. Division 27 – Communications.
- B. General References:
 - 1. City and State or District Ordinances, as applicable to location.
 - 2. IEEE C2, National Electrical Safety Code®.
 - 3. NFPA-70, National Electrical Code®.
 - 4. NFPA-72, National Fire Alarm Code®.
 - 5. NFPA-101, Life Safety Code®.
 - 6. NFPA-255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
 - 7. American National Standards Institute (ANSI).
 - 8. Federal Communications Commission (FCC).
 - 9. National Electrical Manufacturers Association (NEMA).
 - 10. Occupational Safety and Health Administration (OSHA).
 - 11. Americans with Disabilities Act (ADA)
- C. Audiovisual References:
 - 1. BICSI/InfoComm, Audiovisual Design Reference Manual.
 - 2. InfoComm, AV Installation Handbook.

3. InfoComm, Audiovisual Best Practices.
 4. ANSI/INFOCOMM V202.01.2016, Display Image Size for 2D Content in Audiovisual Systems
 5. INFOCOMM F501.01:2015, Cable Labeling for Audiovisual Systems
 6. ANSI/INFOCOMM A102.01:2017, Audio Coverage Uniformity in Listener Areas
 7. ANSI/INFOCOMM 2M-2010, Standard Guide for Audiovisual Systems Design and Coordination Processes
 8. ANSI/INFOCOMM 3M-2011, Projected Image System Contrast Ratio
 9. ANSI/INFOCOMM 4:2012, Audiovisual Systems Energy Management
 10. ANSI/INFOCOMM 10:2013, AV Systems Performance Verification
- D. Work shall comply with the latest edition of applicable standards and codes including updates and addendums. In the event of a conflict, the more stringent standard or code shall be enforced.

1.3 DEFINITIONS

- A. Reference the Division 01 specification for additional definitions.
- B. Final Acceptance: Maryland State Police Representative's acceptance of project from Contractor.
- C. Furnished by Others: Receive delivery at job site or where called for and install.
- D. Maryland State Police Representative: Architect or Engineer having contract directly with Maryland State Police for professional services.
- E. Relocate: Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready to use.
- F. Replace: Remove and provide new item.
- G. Rough-in: Pipe, duct, conduit, equipment layout and installation.
- H. Authority Having Jurisdiction (AHJ): Federal or other regional department, or individual having statutory authority.

1.4 CONTRACTOR QUALIFICATIONS

- A. Be a licensed dealer for equipment specified herein.

- B. Maintain a service department capable of supporting the installed systems as specified herein.
- C. An engineer shall be assigned to oversee technical aspects of this project, and shall hold a current Certified Technology Specialist – Design (CTS-D) certification by AVIXA.
- D. The lead field technician overseeing the installation of this project shall hold a current Certified Technology Specialist – Installation (CTSI-I) certification by AVIXA.
- E. A master control system programmer shall be assigned to this project, and shall be certified by the manufacturer of the control system utilized in the project.

1.5 SUBSTITUTIONS

- A. Comply with the Division 01 specification for contract modification procedures.
- B. The Contractor shall submit to the Maryland State Police Representative supporting documentation that the item proposed for substitution is equivalent to the item specified herein.
- C. The Maryland State Police Representative will make a final determination of approval or rejection.

1.6 SUBMITTALS

- A. Comply with the Division 01 specification related to submittal procedures.
- B. Submit electronic copies of submittals in PDF format, compiled and un-compiled, editable coding as required for future system modification. Additional live formats (CAD, Excel, Word, etc.) are preferred to be submitted at the Contractor's discretion for the Maryland State Police administrative purposes.
- C. Submittals:
 - 1. Shall include, but not be limited to, the following:
 - a. A completed equipment schedule, returned as an unmodified live Excel spreadsheet as originally included in the bid documentation,

complete with quantities and pricing. The AV Contractor is responsible for confirming the accuracy of all formulas and pricing.

- b. A completed equipment schedule, returned in PDF format for record and future auditing, as originally included in the bid documentation, complete with quantities and pricing.
- c. A bid package outlining contractor qualifications, project approach, technical résumés of key personnel, and identification of subcontractors providing services under this scope of work along with a description of work to be performed by each subcontractor.

D. Installation Submittals:

- 1. Shall include, but not be limited to, the following:
 - a. Drawing Index & Title Page.
 - b. Symbols Legend showing all devices, cable types, labelling scheme and any other information required to decipher symbols in the submittal package.
 - c. Floor Plans, Reflected Ceiling Plans, and Sectional View drawings as required to completely document all devices, dimensional locations, and infrastructure requirements.
 - d. System wiring diagrams showing make and model of equipment, logical wire traces, cable types, and any other identifying labels for wiring or ancillary devices.
 - e. Rack Elevations showing rack identifiers, equipment location within each rack, per-outlet power distribution details, and any rack accessories.
 - f. Plate and Panel drawings showing connections, size, finish, color, engraving, and any other information required to document fit and finish of wall plates or floor boxes.
 - g. Riser drawings showing cable routing between wall plates, floor boxes, ceiling devices, racks, and any other devices as required.
 - h. Additional drawings as required, including but not limited to:
 - 1) Custom furniture and millwork.

- 2) Custom display details and equipment mounting.
 - 3) Patch Panel and/or Network Switch Layouts that show port numbering schemes and IP information as required.
 - i. Product data sheets for equipment and cabling, organized logically by system type and indexed for reference. Any parts used but not approved may be rejected at any time.
 - j. Material samples as required.
 - k. Project schedule including key milestones including but not limited to submittal packages, material procurement, rack fabrication and shop testing, installation milestones as applicable, acceptance testing, and completion.
 - l. Images of proposed touch panel layouts, with functional descriptions of buttons and pages. The Contractor will make up to two iterative edits based on comments from the Maryland State Police Representative at no additional cost.
- E. Closeout Submittals:
1. As-built documentation shall be submitted upon completion. This submittal package shall include, but not be limited to, the following:
 - a. All information contained in the Installation Submittal package as organized above, and edited to reflect final conditions.
 - b. Documentation of equipment serial numbers and network/phone/ISDN addressing scheme.
 - c. Software files for touch panel interfaces, source code, DSP, and equipment settings, both compiled and un-compiled code for future system modification.
 - d. Manufacturer product guides and instruction manuals
 - e. Warranty information and product registration as applicable.

1.7 AV SYSTEM DESCRIPTION – Training Room (Room 145)

A. Video Display

1. The display for the Training Center will be a video wall mounted on the plan-east wall.

- a. The video wall is composed of (8) 55" monitors in a 2x4 configuration.
- b. Monitors to be equipped with a narrow bezel creating minimum gap between monitors.
- c. Overall video wall display area will be approximately 15'-10 3/4" W by 4'-5 1/2" H.
- d. The video wall will be capable of showing the following sources:
 - 1) Local PC/laptop at lectern
 - a) A primary and secondary source is available at the lectern
 - 2) Local PC/laptop in seating area
 - 3) Building-wide digital media distribution system
 - 4) Video conferencing
 - 5) Television broadcasts
- e. The video conferencing function will be supported by a wall mounted camera at the front of the room above the video wall., and a second wall-mounted camera at the rear of the room.

B. Audio System

1. Local speech reinforcement and program audio will be provided by a series of recessed ceiling speakers to provide audio from the following sources.
 - a. Local microphones will include
 - 1) Wired gooseneck microphone at the lectern
 - 2) Wireless handheld microphone
 - 3) Wireless lavalier microphone
2. Audience participation in a video and audio conference will be supported by 2 ceiling microphones.

C. Control System

1. The AV system will be controlled by a touch panel at the lectern. Controlled functions will include
 - a. Source selection for display
 - b. Video wall configuration
 - c. Video and audio conferencing control

- d. AV system power on/off
- e. Volume control

1.8 AV SYSTEM DESCRIPTION – Operations Center (140)

A. Video Display

1. The video wall is composed of (8) 55" monitors in a 2x4 configuration.
 - a. Monitors to be equipped with a narrow bezel creating minimum gap between monitors.
 - b. Overall video wall display area will be approximately 15'-10 3/4" W by 4'-5 1/2" H.
 - c. The video wall will be capable of showing the following sources:
 - 1) Local PC/laptop at lectern
 - a) A primary and secondary source is available at the lectern
 - 2) Ten Local PC/laptops in seating area
 - 3) Building-wide digital media distribution system
 - 4) Video conferencing
 - 5) Television broadcasts
 - 6) Feed from local video surveillance system (VSS)
 - a) Coordinate with the owner to tie in to the VSS.
 - d. The video conferencing function will be supported by a wall mounted camera at the front of the room above the video wall., and a second wall-mounted camera at the rear of the room.

B. Audio System

1. Local speech reinforcement and program audio will be provided by a series of recessed ceiling speakers to provide audio from the following sources.
 - a. Local microphones will include
 - 1) Wired gooseneck microphone at the lectern
 - 2) Wireless handheld microphone
 - 3) Wireless lavalier microphone

C. Control System

1. The AV system will be controlled by a touch panel at the lectern.

Controlled functions will include

- a. Source selection for display
- b. AV system power on/off
- c. Volume control
- d. Video and audio conferencing and audio control

1.9 SYSTEM DESCRIPTION - IC Stations (142, 143, 144)

A. Video Display

1. The IC Stations will each include one wall-mounted 49" display monitor
2. Program sources available for display on the display monitor will include:
 - a. A building-wide digital media distribution system
 - b. Television broadcasts

B. Audio System

1. Audio playback will be provided by speakers fitted to the monitor

C. Control

1. Display Monitor Control will be through a wall mounted control panel.
Controlled functions will include
 - a. Source selection for the display
 - b. Monitor power on/off
 - c. Volume control
2. Additional display monitor control will be initiated through use of the handheld infrared remote control provided with the monitor.

1.10 AV SYSTEM DESCRIPTION – Conference Room (141)

A. Video Display

1. The conference room will include one 65" display monitor wall-mounted to the plan-west wall.
2. The monitor will be equipped with a video conferencing bar to allow remote collaboration from the conference room.
 - 1) The video conferencing bar is equipped with a microphone to support voice communication.
3. Program sources available for display on the display monitor will include:

- a. PC at lectern
- b. Laptop at the conference table
- c. A building-wide digital media distribution system
- d. Video and audio conferencing
- e. Television broadcasts

B. Audio System

1. Local program audio support will be provided by a pair of compact speakers fitted to the video display. Program audio sources include:
 - a. Local PC at lectern
 - b. Laptop at the conference table
 - c. Video conferencing
 - d. A building-wide digital media distribution system
 - e. Television broadcasts

C. Control System

1. The system will be controlled by a touch panel controller at the conference table. Controlled functions will include
 - a. Source selection for the display
 - b. Power control for the system.
 - c. Volume control for program audio.
 - d. Video conferencing

1.11 AV SYSTEM DESCRIPTION – Conference Area (124)

A. Video Display

1. The display for the Conference Area will be a wall mounted 75" display monitor at the plan-north wall.
2. The monitor will be equipped with a video conferencing bar to allow remote collaboration from the area.
3. The monitor will be capable of showing the following sources:
 - a. Local laptop input at conference table
 - b. A building-wide digital media distribution system
 - c. Video conferencing
 - d. Television broadcasts

B. Audio System

1. Program audio will be provided by 2 speakers fitted to the display monitor.

C. Control System

1. The AV system will be controlled by a touch panel controller at the conference table. Controlled functions will include:
 - a. Source selection for the display
 - b. Power control for the system.
 - c. Volume control for program audio
 - d. Video and audio conferencing control

1.12 SYSTEM DESCRIPTION – SFMO Classroom (221)

A. Video Display

1. The classroom will include one 75" display monitor wall-mounted to the plan-south wall.
2. Program sources available for display on the display monitor will include:
 - a. Local PC at lectern
 - b. A building-wide digital media distribution system
 - c. Television broadcasts
 - d. Video and audio Conferencing
 - 1) The video conferencing function will be supported by a wall-mounted camera at the front of the room above the monitor., and a second wall-mounted camera at the rear of the room.

B. Audio System

1. Audio playback will be provided by a series of ceiling speakers. Ceiling speakers will be configured to provide audio from the following sources.
 - 1) PC at lectern
 - 2) A building-wide digital media distribution system
 - 3) Television broadcasts
 - 4) Video and audio conferencing
 - 5) One gooseneck lectern microphone
 - 6) One wireless handheld microphone
 - 7) One wireless lavalier microphone

C. Control System

1. The system will be controlled by a touch panel controller at the lectern.
Controlled functions will include
 - a. Source selection for the display
 - b. Power control for the system.
 - c. Volume control for program audio
 - d. Video Conferencing

1.13 AV EQUIPMENT ROOM – (IT Room 121)

- A. Central and non-user accessible AV equipment will occupy AV equipment racks in IT Room 121.

1.14 BUILDING-WIDE AV SYSTEMS

A. Public Address (PA) System

1. A Valcom PA system will distribute voice announcements to selected interior and exterior spaces.
2. Coordinate with the owner to identify the facility VoIP system and configure interface to accommodate three paging zones:
 - a. First floor
 - b. Second floor
 - c. Building exterior

B. Broadcast Television

1. Cable, satellite, or IP-based broadcast television service shall be distributed to selected areas.
2. Six cable or satellite tuners shall be owner provided.
3. Configure a building-wide AV distribution system to accommodate distribution.
4. The concept of operation is that each tuner will be permanently set to a given channel, and those six channels may be selected for viewing by connected display devices.

C. Digital Signage

1. A digital signage system will be provided to distribute informational and promotional audio and video information to display monitors in selected areas.
2. The owner shall be responsible for developing program material for the digital signage system.
3. Digital signage display monitors are located at the following locations:
 - a. Lobby (101)
 - b. Break room (120)
 - c. Second floor Elevator Lobby

PART 2 - PRODUCTS

2.1 SPECIFIC EQUIPMENT

- A. Reference Bills or Materials shown on contract drawings.
- B. Bills or Materials are intended to identify the major components of the systems as it relates to the design intent, and to provide information on the quantities of equipment and systems to be installed.
- C. Provide additional equipment and accessories as required to produce a complete and functional system consistent with the design intent.
- D. Manufacturer master quotes shall be used to convey the design intent. The Contractor shall supplement components as required to provide a complete and functional system.
 1. Reference Extron Master quote # 11646378.

2.2 EQUIPMENT RACKS

- A. Provide all rack accessories as required at no additional cost.
- B. The AV Contractor will be responsible for coordinating proper airflow, ventilation, cooling, power, and dimensional requirements with the General Contractor. Provide ventilation if required to ensure rack temperatures do not exceed 100 degrees Fahrenheit after 3 hours of continuous operation.
- C. Provide low-noise ventilation when racks are open to work areas.
- D. Fill empty rack spaces with black finished blank panels, unless otherwise noted.

- E. Provide and install security covers to restrict access to equipment when adjustment is not required by the end user.
- F. Provide rack shelves for ancillary and/or Maryland State Police-furnished equipment.
- G. Provide caster base to allow rack mobility.

2.3 LECTERNS

- A. Provide a lectern each for the following:
 - 1. Training Room 145
 - 2. Operations Center 140
 - 3. Conference Room 141
 - 4. SFMO Classroom 221
- B. Confirm lectern finish with Architect prior to ordering.
- C. Integrate and test AV equipment into lectern prior to delivery.
- D. Lectern shall be:
 - 1. Middle Atlantic, Pre-Configured L2 Series model: L2LDC2FCMKM with:
 - a. Knotted Maple finish
 - b. WSPC320CBK Desktop Power Center in Black
 - c. L2 Flip-Up Shelf Series SKU: L2-FLIPSHELF-KM
 - d. WSPC320 Desktop Power Center Series SKU: WSPC320CBK

2.4 INTERFACES

- A. Provide a cable with factory molded connectors for each audio, video, and control interface location as specified. Cables shall be flexible, light weight, and of an appropriate length for the application.
- B. Provide AV connection plates within furniture hatches as required for cable terminations and pass-through connections as indicated on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Provide a complete and fully functional AV system; installed, configured, inspected, tested and documented as per the construction documents herein.

2. Provide site presence and full coordination with design team, all involved consultants, contractors, manufacturer representatives, including but not limited to field verification of precursory work, layout and dimensioning, architectural details, power, data, and HVAC requirements.
 3. Provide all licenses, permits, tests, independent testing, factory testing, reports, fees, inspections, and warranties as required.
 4. Provide hoisting, rigging, scaffolding as required to install your work.
 5. Unless otherwise noted, provide specialty boxes (speakers, touch screens, cameras, etc.), trim rings, escutcheons, faceplates, wall plates for your work.
 6. Include any additional cost for labor escalation, material cost increases, etc. associated with this work.
 7. AV network cabling provided for this system are subject to the materials and installation requirements identified in Communication specification section 27 15 00.
- B. Labor
1. The contractor shall commit to completion of all work in adherence to the project schedule. If the Contractor's work is performed in and/or adjacent to facilities that are occupied and in full operation by the Maryland State Police during construction or after the move-in date specified by the project schedule, through no fault of the Contractor, the Contractor will utilize the utmost care to maintain the Maryland State Police use of occupied spaces and the entire facility in the execution of this work. The proposed bid amount shall include all temporary measures necessary including protection, off-hour work, etc., to maintain the Maryland State Police full use of the operation of the facility.
- C. Layout
1. The Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate approximate locations of equipment and components. Changes in the location, and offsets of equipment and components which are not shown on the Drawings but are necessary to

accommodate building conditions and coordination with the work of other trades, shall be made prior to installation, without additional cost.

2. Coordinate layout and sizing for backing, bracing, and structural steel requirements.
3. Field measure conditions necessary to ensure correct fabrication of materials provided by the Contractor.

D. Mounting

1. Permanently attach equipment to the building structure with a minimum safety factor of 5. Suspended components that move or are otherwise subjected to continuous wear or friction shall be supported with a minimum safety factor of 8. When a higher safety factor is recommended by an equipment manufacturer or required by the AHJ, the more stringent requirement shall be met.
2. Provide seismic protection including supports and hangers, as required by applicable code, for your work.
3. Devices shall be securely mounted plumb and straight to walls, floors, or racks per the manufacturers recommended mounting practice. Cables wrapped in a neat organized manner.

E. Protection and Cleanup

1. Provide temporary protection of your work, including wiring and junction boxes prior to hanging drywall and painting. Protect final equipment installations prior to final acceptance e.g. protect monitors/TVs, rack equipment, cameras, etc. from dust and other damage.
2. Painting and touchup of factory finishes and final cleaning of your work prior to Final Acceptance.
3. Perform daily cleanup of all trash and debris resulting from your work. Work areas should be kept broom clean.

F. Cabling

1. All cabling and devices shall be installed in accordance with current BICSI and InfoComm standards and best practices.

2. CAT6A F/UTP cabling shall be used with appropriate shielded 8P8C RJ45 connectors for all permanent links specified herein and intended for use with the AV System.
 3. SDI cabling and connectors shall adhere to SMPTE ST2082-1 video standard for all permanent links specified herein for 12G-SDI video. The AV Contractor shall demonstrate cabling meets or exceeds SMPTE or manufacturer's specifications for acceptable return loss. The AV Contractor shall provide and install appropriate crimp connectors as recommended by the cabling manufacturer. Refer to section 3.2 for acceptance testing demonstration requirements.
 4. Provide cable service loops at devices for inspection, minor adjustment, and future flexibility.
 5. Furnish, layout, and install "J" hooks and support for installed cabling in accessible spaces above ceiling.
 6. Ethernet cabling installed in support of AV systems shall be subject to requirements expressed in section 271500.
- G. Labeling:
1. Reference and adhere to INFOCOMM F501.01.2015 – Cable Labeling for Audiovisual Systems.
 2. Permanently label all devices mounted in equipment racks to coordinate with the nomenclature used on the Drawings. Indicate the location and function that the equipment serves. Use thermal ribbon labeling from label printers such as P-Touch or DYMO.
 3. Permanently label receptacles, plates, ports, and jacks in a logical manner clearly indicating their function in the system. Architecturally visible plates shall be engraved if possible, otherwise use thermal ribbon labeling from label printers such as P-Touch or DYMO.
 4. Provide unique cable markers on both ends of every cable in the system. This should use a logical numbering scheme and should coordinate with in-house numbering schemes already in use. Markers shall be a clear

heat-shrink or self-adhesive type and shall be within 6 inches of each termination.

5. Clearly and logically label external devices such as audio mixers, wireless microphones, belt packs, and assistive listening receivers. Use thermal ribbon labeling from label printers such as P-Touch or DYMO.
6. Label relevant inputs and outputs on switchers, matrices, and mixers. This includes digital/virtual labelling of audio channels and video inputs and outputs.
7. Label telephone numbers, ISDN numbers and IP addresses of pertinent devices.

H. Electrical Power and Grounding:

1. Reference ANSI/INFOCOMM 4:2012 – Audiovisual Systems Energy Management.
2. Provide grounding and bonding for your work in accordance with applicable codes.
3. No circuit shall exceed 80% of full power.
4. Provide and install rack-mounted power supplies for remote power to AV transmitters and receivers when possible. This includes external power supplies to AV matrix switchers, or PoE network switches to supply power.
5. Grounding shall be in compliance with the manufacturer's specification for all appropriate equipment.

I. Equipment Racks:

1. Reference BICSI/InfoComm, Audiovisual Design Reference Manual.
2. Reference InfoComm, AV Installation Handbook.
3. Velcro style cable wraps shall be used in vertical wire management. Plastic cable ties or "zip" ties are not acceptable.

J. Control System Programming:

1. Reference Infocomm's "Dashboard for Controls".
2. Coordinate control system with Maryland State Police and adhere to the approved control system touch panel submittal.
3. Label buttons using notation that is consistent with the Drawings, unless otherwise noted in submittal comments.

3.2 ACCEPTANCE TESTING

- A. Comply with ANSI/INFOCOMM 10:2013 – AV Systems Performance Verification.
- B. Verification Sequence:
 - 1. The Contractor shall identify parties responsible for verification and stakeholders who wish to be involved in the process
 - 2. The Contractor shall identify when verification is to be performed, and confirm system completion, availability, and provide notice prior to performing verification
 - 3. The Contractor shall identify test procedures and submit a testing check list for approval, including the definition of measurements and test equipment.
 - 4. Installation shall be complete.
 - 5. The Contractor shall independently perform system acceptance testing and submit all verification checklists and documentation to the Consultant.
 - 6. As part of the system acceptance testing the Contractor will perform full bandwidth testing of all twisted pair cabling and properly document and submit all testing results to the Maryland State Police. Utilize appropriate professional network testing gear to determine full adherence to cabling standard.
 - 7. As part of system acceptance testing the Contractor will perform SMPTE 12G testing of all coaxial cabling identified on drawings as 12G-SDI. Professional equipment such as Leader LV5600 or Phabrix Qx with appropriate software options shall be used for physical layer test or "eye pattern" plus jitter scoped and captured for each cable. Provide report of variance and data from each cable tested prior to Maryland State Police Representative verification.
 - 8. The Maryland State Police Representative will perform an independent verification. The Contractor shall perform all work necessary to determine

and/or modify performance of the system to meet the requirements of this specification.

- a. Provide a qualified technician knowledgeable with the system and the installation to assist the Maryland State Police Representative with the acceptance procedure.
- b. The Contractor shall provide all labor, materials, tools, and measurement equipment necessary for these demonstrations, tests and adjustments.
- c. As-built documentation, as detailed herein, shall be on hand for reference.

3.3 PROJECT CLOSE OUT

A. Warranty:

1. For a period of one (1) year(s) from Final Acceptance, and for as long as product manufacturer's warranty is active, the Contractor shall replace equipment within 24 hours of first notification. Complete repairs to equipment within 72 hours. If repairs cannot be completed during this period, or if ordering of parts is required, provide a status update to the Maryland State Police every 72 hours documentation of repairs. These terms shall be accepted at no additional cost.
2. For a period of three (3) year(s) from Final Acceptance, the Contractor shall repair system deficiencies that result from improper installation, imperfect materials, or poor workmanship. These terms shall be accepted at no additional cost.
3. For a period of three (3) year(s) from Final Acceptance, the Contractor shall perform annual maintenance to make any necessary adjustments and bring the system back to optimal performance. These terms shall be accepted at no additional cost.

B. Demonstration and Training:

1. Provide 8 hours of system training and orientation for the Maryland State Police personnel. A technician familiar with the system provided and qualified to give technical guidance should conduct the training.

2. To ensure a smooth transition of ownership, conduct training prior to the first use the system. Training may be held at a time outside of normal business hours at no additional fee.
 3. Training shall include, but not be limited to:
 - a. An overview of the physical installation, equipment, and cabling.
 - b. Review of systems documentation and test results.
 - c. Instructions on manufacturer maintenance procedures to enable Maryland State Police personnel to successfully maintain the system.
 - d. Minimum of an additional two (2) hours dedicated for configuration setup and demonstration of a basic slideshow on the specified signage player(s).
- C. Go-Live Support
1. Provide one service technician for 24 man-hours starting on the first scheduled use date. For a period of one (1) week(s) after this period, provide necessary support to ensure 2-hour response time to issues that arise.

END OF SECTION

SECTION 275000 - DATA, VOICE AND VIDEO SYSTEMS

PART 1 – GENERAL

1.1 SCOPE

- A. Provide a complete system of wired data, voice and video outlets suitable for distribution and utilization of signals from the MSP supplied telephone systems, computer data networks and Cable television.
- B. The data network wiring shall be suitable for a minimum 1000 Mega-Bits per second (Mb/s) data network.
- C. The Data and Voice Structured Cabling and Outlet System shall include, but is not necessarily limited to:
 - Category 6 Unshielded Twisted Pair (UTP) Cable
 - Air Blown Fiber Optic Cable – **Sumitomo Future Flex with Corning Glass**
 - RJ-45 modular jacks with integral IDC type connectors
 - Wall mounted or stand-alone data cabinets
 - Type 110 wiring punch blocks for voice cables
 - 48 Port Category 6 Modular Patch Panels
 - RG-6 Quad Shielded Video Cable
 - Video taps, coaxial cables and signal distribution equipment
- D. Any questions regarding the Structured Cabling System, or the equipment to be used shall be resolved prior to bid.
- E. Contractor shall visit the site, verify all existing items specified, and be familiar with the working conditions, hazards, phasing and local requirements involved. Contractor shall take these existing conditions into consideration and the lack of specific information in these specifications shall not relieve the Contractor of any responsibility. Provide temporary cabling, supports, terminations, outlets, and all product required to keep existing system operational until new system is complete. Provide temporary cabling and provisions to maintain the system for each phase of construction. Contractor shall provide all field investigations to determine all conditions and circumstances and gather all data and information required for work. Contractor shall survey all equipment and cable routes and wiring devices. Contractor shall provide complete field investigations and coordination to determine and provide all temporary cabling and provisions to maintain systems operation. The contractor shall assume that all information shall be obtained from contractor field surveys and not from contract documents. Contractor shall remove temporary provisions when the need for its services has ended, when

it has been replaced by the contractor provided permanent facility.

- F. Contractor shall protect and maintain existing voice/data/video systems in pass through project site and shall reroute fiber and copper cabling to avoid damage . Contractor shall trace, locate and identify all existing voice/data/video cabling. Provide relocation of existing and new supports for existing cabling. Provide temporary voice/data/video cabling to maintain operation of existing systems.
- G. Existing communication and data cabling outside building is the result of various installations over the years. Cable type and installation technique varies. All affected existing telephone and network cabling and associated components shall be removed and disposed of unless otherwise directed by Owner. Existing cable routing varies. **Provide temporary fiber and copper cabling as required to maintain service.**
- H. Contractor shall provide new cabling supports and shall NOT assume that any existing cabling supports exist or can be re-used.

1.3 STANDARDS

- A. Voice and data outlets, wiring and associated work shall be in strict accordance with the requirements of the MSP Office of Information Technology.
- B. Cable television outlets, wiring and associated work shall be in strict accordance with the requirements of Comcast or Verizon Communication services.

1.4 COLOR CODING

- A. All cabling, jacks, inserts and other system components shall be color coded to identify data versus voice (telephone) facilities. Color codes shall be as specified below, in accordance with the standards set by the MSP Office of Information Technology.
 - 1. Data Wiring and Jacks: Green
 - 2. Voice (Telephone) wiring and jacks: Green
 - 3. Fiber optics – multi mode: Aqua (OM3 or OM4)
 - 4. Fiber optics – single mode: Yellow
 - 5. Cable TV & IP video monitors: Black
 - 6. Emergency/alarm wiring: Red
 - 7. Radio communication: Blue

1.5 SYSTEM DESCRIPTION

- A. System includes provision of combination data and/or voice single or multi-jack outlets at locations and in configurations indicated on the drawings, with station cables from each jack to the appropriate termination as specified herein.
- B. Typical workstation outlet configurations shall be as indicated on the drawings. Where both voice and data jacks to be provided in the same outlet, the voice jack shall be located at the upper left position.
- C. Wall mounted telephone outlets shall be provided with a single, flush mounted RJ-45 modular wiring jack mounted in a stainless steel wall plate with wall telephone instrument mounting lugs.
- D. Outlets designated on the plans for pay phones shall consist of a single gang cover plate with single 3/8" diameter bushed hole. Coil 24" of station cable slack within outlet box for direct connection to pay telephone instrument by the telephone equipment provider.

1.6 SUBMITTALS

- A. General: Submit the following according to "Basic Electrical Requirements". Submit product data on each product specified in this section, including, but not limited to the cabinets and cabinet components, cabling, and cabling components, rack hardware and accessories, patch cord organizers and cable ring wiring path blocks, fiber optic cable, multipair telephone cable, Category 6 UTP cable, cable end connectors, wireways, cable management, surge protectors, conduit, and other raceways and associated components, jacks, etc., in a bound, jacketed loose-leaf binder. Each item proposed should be tagged with a star, an arrow, etc.
- B. Product Data and Shop Drawings: Submit these items, and the Certifications specified below, as a complete package. Incomplete submittals will not be reviewed.
 - 1. A complete schedule of equipment and materials that are to be furnished for the work. Accompanying the schedule shall be manufacturer's specifications or cut sheets for each major component.. Original specification sheets or clear copies of same shall be submitted on all items. Manufacturers name, make and model number shall appear on each sheet. Submittals shall be bound in booklet form with cover sheet and index, and presented in

a neat and logical order in a binder.

2. Complete drawings of equipment racks and special assemblies. Each drawing shall show all equipment with its manufacturer and model number.
3. Complete drawings detailing installation locations of equipment, cable quantities and types with terminal block or patch panel locations.
4. Certification reports for all data wiring run shall be submitted in pursuance with the rules outlined in the "Cable Testing and Acceptance" section of this document.
5. Submit Shop Drawings of each proposed system (Voice/Data/Video) indicating the proposed system configuration and all specified requirements. Shop Drawing shall indicate proposed cable routing, detail installation locations of equipment, cable quantities, cable types, and terminal block locations. All Shop Drawings shall be Contractor's original drawings. Submission of Engineer's Contract Drawings as Shop Drawings is not permitted. A detailed set of floor plans for the complete building shall be furnished showing the locations of all equipment and devices and their required interconnections. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification.
6. Provide complete customized shop drawings , including air blown fiber shop drawings, indicating all aspects of the outside plant work.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. The installing contractor shall submit proof of having installed at least six (6) similar Data And Voice Structured Cabling And Outlet Systems. These systems shall have been in service for a minimum of three (3) years. These systems must have been within a fifty (50) mile radius of the project location. Included with this proof shall be the customer name, customer contact and telephone number, and, if applicable, the architect and electrical engineer on the project. The Architect and Owner retain the right to reject any installing contractor who, in their sole judgment, has not met the above criteria or has received a less than favorable reference from any of the submitted references OR from any other customer for which the installing contractor has performed similar installations, whether or not such customer has

been listed on the submittal.

2. In order to assure full compliance with all codes and regulations, the installing contractor must have on its regular staff a Master Electrician licensed within the jurisdiction in which the installation occurs. Proof of such licensing must be included with the original submittal.
 3. The Contractor shall make application for all necessary permits, licenses and inspections as required by the Authority Having Jurisdiction, and shall pay all fees and charges appurtenant thereto.
 4. The installing contractor must hold a current certification from manufacturer of the Cabling System being proposed for installation. Proof of such certification must be included with the original submittal.
 5. Work will be supervised by a registered communications distribution designer (RCDD) during all phases of the installation.
 6. **Contractor shall be licensed and certified to install air blown fiber (by Sumitomo Electric Lightwave). Contractor shall be a LFI Partner.**
- B. Manufacturer Qualifications: Materials proposed for use on this project shall be provided by a manufacturer experienced in manufacturing components listed and labeled under EIA/TIA-568A and who comply with these Specifications.
- C. Comply with NFPA 70, "National Electrical Code.", latest edition
- D. Comply with the latest editions of following industry standards:
1. ANSI/EIA/TIA 568-B Commercial Building Telecommunications Cable Standard
 2. TIA 568-B.1-2000 Commercial Building Telecommunications Wiring Standard
 3. EIA/TIA 569A Commercial Building Standard for Telecommunications Pathways and Spaces
 4. EIA/TIA 606 Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings
 5. EIA/TIA 607 Commercial Building Grounding and Bonding Requirements for Telecommunications

1.8 WARRANTY

A. Special Warranty Requirements:

1. All installation materials furnished and installed by the Contractor shall be fully guaranteed against defects in materials and workmanship for a minimum period of two (2) years after final acceptance by MSP Office of Information Technology. A standard manufacturer's warranty, on parts and labor or two (2) year warranty on parts and labor, whichever is greater shall be included as part of these conditions. Defective items must be replaced free of charge during the warranty period.
2. In the event that the certified system ceases to support the certified application(s), whether at the time of cut-over, during normal use or when upgrading, the manufacturer and vendor shall commit to promptly implement corrective action.

1.9 SITE SURVEY

- A. Provide examination of site as required by specifications.
- B. Prior to placing any cable pathways or cable, the Contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables, and to arrange the removal of any obstructions with the Project Manager accordingly.
- C. The Drawings provided are diagrammatic and generally representative of the existing conditions, but not necessarily accurate in all aspects; therefore, verification of these drawings is solely the responsibility of the Contractor. The Contractor shall verify all field conditions and make field measurements as required.
- D. Visit the site before submitting bid and check location of utilities, check conditions, verify dimensions and locations shown on the plans, and verify over-all costs and work herein described or shown.
- E. Take measurements necessary for this work and be responsible for their accuracy. Necessary pullboxes and junction boxes as required to accomplish distribution shall be provided

PART 2 – PRODUCTS

2.1 TWISTED PAIR CABLES, CONNECTORS, AND TERMINAL EQUIPMENT

- A. Station cables for data jacks shall be four (4) pair Category 6 unshielded twisted pair (UTP), plenum-rated solid conductor cable conforming to the ANSI/TIA/EIA-568-B.2 Category 6 component specifications standards. Cable frequency capability shall be 250 MHz or greater and shall exceed IEEE 802.3ab and IEEE 802.3af.
- B. Station cables for voice jacks shall be four (4) pair Category 6 unshielded twisted pair (UTP), plenum-rated solid conductor cable conforming to the ANSI/TIA/EIA-568-B.2 Category 6 component specifications standards. Cable frequency capability shall be 250 MHz or greater and shall exceed IEEE 802.3ab and IEEE 802.3af.
- C. UTP Cable Connecting Hardware: Comply with EIA/TIA-568A, TSB 40. Insulation displacement connector (IDC) type, using modules designed for use with punch-down tools.
 - 1. IDC Terminal Block Modules: Integral with connector a body, including plug and jacks where indicated.
 - 2. IDC Connecting Hardware: Consistent throughout Project.
- D. Jacks and Jack Assemblies for UTP Cable: Modular, color-coded, RJ-45 receptacle units with integral IDC-type terminals.
- E. Workstation Outlets: Multiple jack/connector assembly mounted in a single gang faceplate.
 - 1. Faceplate: High-impact modular white or ivory ABS plastic.
 - 2. Mounting: Semi-flush, except as otherwise indicated. All unused mounting spaces shall be equipped with a blank insert.
 - 3. Legend: Provide jacks in color corresponding to those specified above under "Color Codes". Label jacks in accordance with the specifications listed in this document. Provide facilities for insertion of machine printed jack identification label behind plastic cover. Install machine printed labels at each jack location.

2.2 FIBER OPTIC SYSTEM

- A. Provide AIR BLOWN FIBER rated outdoor/indoor fiber optic with minimum 12 strands per run.
- B. Provide rack mounted fiber termination enclosure fully loaded , with "LC/UPC" type connectors. Fiber Optic Patch panels shall permit the use of pre-terminated or on-site terminated fiber optic cables. Cables shall be managed using the included retaining clips.

- B. **Corning Glass with Sumitoma Future Flex Air Blown Fiber** and fiber are basis of design and currently used at the MSP campus. . Cable from other manufacturers will be considered. All cable installed must be pre-approved by the MSP Office of Information technology prior to installation.

2.3 DATA/VOICE PATCH PANELS

- A. Patch Panels shall be 48 port, Category 6 TIA/EIA-568-B, Hubbell NEXTSPEED 6 or equivalent approved by MSP Office of Information Technology.
- B. Data Patch Panels shall be modular panels consisting of multiple numbered jack units with connectors of the IDC type at each jack to provide permanent termination of conductor pair groups of installed cables. Patch Panels shall be Category 6 48 port as required to provide the necessary number of ports for the installation plus at least 20% spare ports (minimum fifteen (15) empty ports) for future expansion.
- C. Panels shall be mounted in equipment cabinets or racks, with one(1) 2U horizontal cable management bracket per patch panel, and vertical cable management where appropriate.

2.4 EQUIPMENT RACKS/CABINETS

- A. Wiring Closets and Main Data Room
 - 1. Refer to Specification Section 16820 "Communications Equipment Room Fittings" for equipment rack specifications.
 - 2. Rack/Wall mount LIU for Fiber Optic Cabling termination. LIU's should be sized to provide for 20% additional growth.
 - 3. All rack equipment that is to be installed shall be pre-approved by the MSP Office of Information Technology.

2.5 VOICE SYSTEM

- A. Voice horizontal CAT6 cabling shall be identical to Data horizontal CAT6 cabling. Terminate voice cables on 48 port CAT6 patch panels. Conforming to the TIA 568-B wiring pattern.
- B. Provide multi-pair (25 pair) voice indoor/outdoor rated copper voice backbone cable from the existing campus Main telephone room (2nd floor

of Waterloo Barrack) to each telecom room in the new Tactical Ops Admin Building, Existing Property Services Building and Existing Tactical Service Garage. Voice backbone cables shall be Hitachi, Berk-Tek power sum Cable or approved equal.

- C. Terminate copper voice backbone cable on 110 blocks at each end. Voice Termination Punchblocks shall be AT&T 110-300 or approved equal. Provide a sufficient quantity of the required 110 type hardware to terminate all voice backbone cables being installed under this contract. Provide all required stand-off brackets, D-Rings, and cable dressing hardware to provide, a neat and workmanlike installation.
- D. Provide copper building entry protection panels on each end of the outside plant multi-pair copper cables.

2.6 VIDEO OUTLETS, CABLES, AND MISCELLANEOUS EQUIPMENT

- A. Video (RF) Jacks shall be standard "F" connector feed through type jacks, Ortronics 6090017 or approved equal. Each jack shall be fed by an RG6 coaxial cable. Coil twenty (20) foot service loop at existing telephone backboard for connect to cable television service by Comcast Cable Television. Tag each cable as to location served.
- B. Video Drop Cable shall be a plenum rated quad shielded RG-6 coaxial cable with an 18 AWG solid copper center conductor, a 100% Bi-foil shield and a 65% aluminum braid shield. Video drop cable shall be West Penn, Commscope or approved equal.
- C. Video System RG-6 Connector shall be a two-piece crimp on type. Provide Blonder Tongue BTF-561 or approved equal.
- D. System Tap offs shall be Toner Model TGT four (4) and/or eight (8) port Tap offs or Blonder-Tongue Model SRT-4A four (4) and SRT-8A eight (8) port Tap offs.
- E. Provide input cable from Utilities Demarq to MDF. Input cable shall be Time Fiber TX Series Flexible Feeder model # 02852V TX15AQ-VBV Flame Retardant Quad Shield terminated with Amphenol ACC-15BAFFT10U or Gilbert G-15Q-BAFF TX Quad connectors specific to this cable.
- F. Provide riser video cable from MDF. Riser video cable shall be Time Fiber TX Series Flexible Feeder model # 02852V TX15AQ-VBV Flame Retardant Quad Shield terminated with Amphenol ACC-15BAFFT10U or Gilbert G-15Q-BAFF TX Quad connectors specific to this cable.

- G. Provide a minimum of one (1) Blonder-Tongue model #5800P-73 BIDA 75A-30P 5-36,49-750MHz WITH Integrated Active Return Broadband Indoor Distribution Amplifier in the Head End (MDF) (as a launch amplifier) to provide a fully functional catv system. Provide necessary internal pads and equalizers to balance the installed system.

PART 3 – EXECUTION

3.1 EXAMINATION:

- A. Examine pathway elements to receive cable. Check raceways and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Do not proceed with installation until all conditions have been deemed satisfactory.

3.2 INSTALLATION COPPER BASED CABLES:

A. Wiring Methods:

1. Extend a minimum of two data station cables from each jack to the location indicated in the Schedule of Telecommunications Outlets on the drawings, and terminate on Category 6 patch panel.
 2. Extend a minimum of three (3) station CAT6 cables from each standard outlet (containing three CAT6 jacks) to the location indicated on the drawings, and terminate on Category 6 patch panel..
- B. Termination of voice and data station cables shall be in accordance with EIA/TIA 568A, Designation T568B for Category 6 cable. Verify jack termination scheme with MSP Office of Information Technology.
 - C. Install components as indicated, according to manufacturers' written instructions. Use techniques, practices, and methods that are consistent with the Category 6 rating of the components and that assure Category 6 performance of completed and linked signal paths, end-to-end.
 - D. Install cable without damaging conductors, shield, or jacket.
 - E. Do not bend cable in handling or installation to smaller radii than minimums recommended by manufacturers.
 - F. Pull cables without exceeding cable manufacturer's recommended

pulling tensions.

- G. Pull cables simultaneously where more than one is being installed in the same raceway or cable run.
- H. Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation.
- I. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway.
- J. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.
- K. Secure and support exposed cable at intervals not exceeding 30 inches and not more than 6 inches from boxes, cable trays, fittings, racks, frames, and terminals.
- L. Separation of Wires: Comply with EIA/TIA-569 rules for separation of unshielded copper voice and data system cables from potential EMI sources, including electrical power lines and equipment.
- M. Make splices, taps, and terminations only at outlets, terminals, and cross-connect and patch panels.
- N. Use splice and tap connectors compatible with media types.

3.3 INSTALLATION FIBER OPTIC CABLES

- A. Multimode Fiber - Installed cable shall be 50 micron core/cladding, enhanced grade, multimode, and graded index glass fiber. All materials in the cable shall be dielectric.
 - 1. Performance: Installed fiber must meet or exceed the performance specifications laser optimized fiber optic cabling.
 - 2. Cable Construction: Installed cable must be manufactured to meet or exceed the following specifications:
 - a. Plenum Cable (Inside Cable): Plenum rated cable shall be used for all interior installations. Installed cable shall meet or exceed the following specifications:
 - 1) Tight buffered 900 um, mechanical strippable Teflon (for plenum applications).
 - 2) EIA/TIA -598 color coding for fiber optic cable.

- 3) Aramid yarn strength member, capable of supporting a short-term tensile load of 400 lb. without stretching.
- 4) Capable of bend radii as small as 20 x outside cable diameter (under installation load) and 10 x outside cable diameter (long term load).
- 5) Capable of a minimum crush resistance of 850 lb./in.

b. Outside Plant Cable: Outside plant cable shall be used for all applications where cable is to be run in underground conduits. Outside plant cable may not be used or interior applications and shall meet the following specifications:

- 1) Gel filled buffer tube, 250 um, acrylate.
- 2) EIA/TIA-598 color coding for fiber optic cable.
- 3) Flooded core
- 4) Capable of bend radii as small as 20 x outside cable diameter (under installation Load) and 10 x outside cable diameter (long term load).
- 5) Capable of a minimum crush resistance of 850 lb./in

B. Single Mode Fiber: Installed cable shall be 8.3/125 micron core/cladding, single mode, and graded index glass fiber. All materials in the cable are to be dielectric.

1. Performance: installed fiber must meet or exceed the following performance specifications.

Fiber cable types	Wavelength (nm)	Max. Attn. (dB/Km)
Singlemode, Inside plant	1,310	1.0
	1,550	1.0
Singlemode, Outside plant	1,310	0.35
	1,550	0.2

2. Cable Construction: Riser or plenum rated cable shall be used for all interior installations. Installed cable shall meet or exceed the following specifications:

a. Riser or Plenum (Inside Cable): Riser cable shall be used for all interior installations and shall meet the following specifications:

- 1) Tight buffered 900 um, mechanical strippable Teflon.
 - 2) EIA/TIA -598 color coding for fiber optic cable.
 - 3) Aramid yarn strength member, capable of supporting a short-term tensile load of 400 lb. without stretching.
 - 4) Capable of bend radii as small as 20 x outside cable diameter (under installation load) and 10 x outside cable diameter (long term load).
 - 5) Capable of a minimum crush resistance of 850 lb./in.
- b. Outside Plant Cable: Outside plant cable shall be used for all applications where cable is to be run in underground conduits. Outside plant cable may not be use for interior applications and shall meet the following specifications:
- 1) Gel filled buffer tube, 250 um, acrylate.
 - 2) EIA/TIA -598 color coding for fiber optic cable.
 - 3) Flooded core
 - 4) Capable of bend radii as small as 20 x outside cable diameter (under installation load) and 10 x outside cable diameter (long term load).
 - 5) Capable of a minimum crush resistance of 850 lb./in.
- C. Fiber ends are to be terminated in SC-type connectors with composite ferrules. They must be of the "epoxy and polish" variety.

3.4 INSTALLATION AT EQUIPMENT ROOMS AND WIRING CLOSETS

- A. Provide adequate length of conductors and cables. Train the conductors to terminal points with no excess. Provide a minimum of ten (10) feet of service loop for all cables within Equipment Room, but not inside of rack enclosure. Use cable management system to restrain cables, to prevent straining connections, and to prevent bending cables to radii smaller than allowed.
- B. Mount voice punch blocks, terminal strips, and other connecting hardware on plywood backboards, except as otherwise indicated. Provide additional ¾" fire retardant treated plywood backboards where required for mounting of equipment.
- C. Mount data patch panels in floor or wall mounted electronic racks, with cable management. Do not fill racks to more than 66% capacity to allow room for owner furnished equipment. Provide additional racks, to match existing, where required to maintain rack space.
- D. Group connecting hardware for cables into separate logical fields.

- E. All unarmored fiber cable is to be protected with inner duct. After installation, inner ducts are to be permanently labeled as containing fiber optic cable. Instruction for labeling will be provided by MSP Office of Information Technology.

3.5 IDENTIFICATION

- A. Labels at corresponding ends of each cable must be consistent and accurate.
- B. Data Cabling:
 - 1. Data patch panels shall be labeled alphabetically beginning with "A" from top to bottom of the equipment rack. Letters shall not be repeated within the same wiring closet.
 - 2. Data station terminations shall be labeled with their corresponding wiring closet room number, where applicable, patch panel letter and port number.
- C. Voice Cabling:
 - 1. Voice termination blocks shall be numbered sequentially. Numbers shall not be repeated within the same wiring closet.
 - 2. Voice station terminations shall be labeled with their corresponding block number. For installations where 2 voice lines are being split from one cable, the voice jack containing the Blue and Orange pairs shall be labeled with the corresponding number as well and the letter 'A', and the jack containing the Green and Brown pairs shall be labeled with the corresponding number as well as the letter 'B'.
- D. Fiber Optic Cabling: Each cable and inner duct is to be permanently labeled at each end with a unique cable number. In addition, labels shall be affixed to the cable/inner duct at every transition of a vault, hand hole, riser closet, or major pull box.

3.6 SLACK

- A. In the work area, a minimum of 300 mm (12 in) should be left at outlets, while 1 m (3 ft) be left at the backboard or rack, and 6 m (20 feet) in the closet area.

- B. In telecommunications rooms a minimum of 6 m (20 ft) of slack should be left for all cable types. This slack must be neatly managed on trays or other support types. "All cable types" includes all voice/data/video backbone cables and fiber optic backbone cables.
- C. All unused cables shall be properly terminated, as specified, with 10 m (33 feet) extra cable neatly coiled and tie-wrapped at the workstation end of cable in the ceiling space.
- E. Where wireless access point devices are installed, provide a minimum of 3 m (10 feet) of cable coiled, tie-wrapped, and supported in the ceiling space.

3.7 CABLE TIE WRAPS

- A. Tie wraps shall be used at appropriate intervals to secure cable and to provide strain relief at termination points. These wraps shall not be over tightened to the point of deforming or crimping the cable sheath. Tie wraps shall be attached with screws to walls, backboards, and other structures. Tie wraps shall be spaced between 6" and 10" apart, 8" on the average.
- B. Hook cable managers should be used in the IDF/MDF room where reconfiguration of cables and terminations may be frequent. Cable Managers shall be Polygon Softcinch Series, or approved equal.
- C. No "stick-on" cable wraps, raceways, or terminal devices are acceptable.

3.8 SYSTEM ACCEPTANCE TESTING

- A. The Cable System Installer shall document the cable system testing methodologies in detail, including the scope, procedures and acceptance criteria for testing. The testing process shall be comprised of the test cycles outlined below. All test results (e.g. cable lengths, test result values, etc.) shall be documented in both hard copy and electronic format for review and approval by the MSP Office of Information Technology. Test results should be e-mailed to [the MSP Office](#). Electronic format shall be provided using one of the products available in the Microsoft Office Suite (Word, Excel, etc.), and shall be provided on CD-ROM.
- B. The Cable System Installer shall provide all necessary diagnostic tools (i.e. Optical Time Domain Reflectometer (OTDR), cable scanner, meters, logging equipment, etc.) The Cable System Installer shall describe any testing tools that are used, along with the capabilities and limitations of these tools.

C. Cable System testing shall be conducted after installation is complete. Upon completion of all prerequisite tasks to the corresponding test, the Cable System Installer shall notify the MSP Office of Information Technology, in writing, that the relevant portion of the cabling system is complete and ready for inspection.

D. Acceptance Test Guidelines:

1. All copper cabling and terminations shall be tested, characterized and documented. At a minimum, the following tests must be performed:
 - a. Continuity Testing shall be performed to determine that the copper conductors are continuous with no opens or shorts.
 - b. Cable Characteristic Testing shall be performed to measure the intrinsic characteristics of a copper cable segment. Information derived from this test shall include the cables near end crosstalk (NEXT), capacitance, and characteristic impedance. This test shall be conducted on all installed end-to-end cable sections.
 - c. Time Domain Reflectometer (TDR) shall be used to evaluate copper loss per unit length (Db/ft) to measure both the quality and length of copper cable. The TDR information shall be used to verify that the cable meets required IEEE 802.3 specifications for 1000BaseT connections over unshielded twisted pair cable.
 - d. Termination Testing shall be performed after the cable has been installed to verify that all cable pairs have been properly terminated. This testing shall assure that the pin-outs are correct and that there have been no flipped or incorrectly terminated pairs.
 - e. Link Confidence Testing shall measure the copper cables ability to support 1000 Mb/s (Gigabit Ethernet).
 - f. The matrix below defines when each of the above tests shall be performed:

Copper Cable Test Requirements				
Unit Test Name	On-Reel	After Install	Post Term.	Final Test
Continuity Test		!	!	
Cable Characteristic Test				!
Time Domain Reflectometer (TDR)			!	!
Termination Testing			!	!
Link Confidence Test @100 Mb/s			!	!
Link Confidence Test @1000 Mb/s			!	!

2. All single mode and multi mode fiber strands shall be tested end-to-end for bi-directional attenuation, and 1310 nm/1550 nm for single mode fibers. Tests should be conducted in compliance with EIA/TIA-526-14 or OFSTP 14, Method B, according to the manufacturer's instructions for the test set being utilized.
 - a. After termination, each fiber shall be tested with an ODTR for length, transmission anomalies, and end-to-end attenuation. Results are to be recorded and supplied to MSP Office of Information Technology in the form of hard-copy printouts.
 - b. After termination and bulkhead mounting, each terminated fiber is to be tested for end-to-end loss with a power meter/light source. As above, results are to be recorded and supplied to MSP Office of Information Technology.
 - c. The maximum allowable attenuation for any splice or termination is 0.3 dB.

D. CATV System Acceptance Tests:

1. Coaxial Cable Plant Testing shall consist of a sweep test of the cable plant provided under this Contract to verify installed cable bandwidth and distortions.
2. A Cumulative Leakage Index (CLI) survey shall be made to verify system integrity. Section 76.605(a)(h) of the FCC states that signal

leakage must not exceed 20 micro-volts/meter from 54 MHz to 216 MHz at 3 meters and 15 micro-volts/meter at all other frequencies.

3. The Contractor shall test and for the following:
 - a. Test all specialty video cables for open, short, and ground.
 - b. Test all specialty video cables for end to end signal performance.
 - c. Test picture quality at each specialty outlet.
 - d. Test cables for frequency response and insertion loss at 5-1000 MHZ.

3.9 CLEANING

- A. On completion of system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

3.10 DOCUMENTATION:

- A. The conditions of the General Provisions (General, Supplementary, and other Conditions) and the General Requirements are hereby made a part of this Section.
- B. A comprehensive installation, operation, programming and instruction manual shall be supplied as part of the system. The manual shall provide complete service information, including schematics, layout drawings, and interconnecting diagrams showing the location of all the outlets, cable taps, cable routes, and other installed components. Include final revised one-line system drawings. Include for this particular project parts lists to permit quick and efficient maintenance and repair of the equipment by qualified technicians. Manuals shall include 8-1/2" x 11" device location/cabling route drawings provided in CADD format Autodesk - AutoCadd Release 2010 or later (.dwg/.dxf) on CD disk. Manuals shall include a copy of the operations manuals listed below. Manuals shall be indexed and placed in a hard-cover three ring binder. Three (3) copies of this manual shall be provided to the Owner upon project completion. Contractor shall retain a minimum of one (1) copy for their permanent records. Provide one copy of Manual and disk(s) in the Main Equipment Rack. Refer to "General Provisions" in the contract for additional requirements or for documentation requirements.

3.11 DRAWINGS

- A. As-built drawing shall be provided by the Contractor, in compliance with EIA ANSI/TIA/EIA-606, showing the locations of and identifiers for all:
 - 1. Horizontal cable routing and terminations.
 - 2. Telecommunications outlets/connectors, Telco System interfaces.
 - 3. Backbone cable routing and terminations and outlets.
 - 4. Video cable routing and terminations and outlets.
 - 5. Data cable routing and terminations and outlets.
 - 6. Electrical power cable routing and terminations, power outlet locations.
 - 7. Network cabling plans identifying type, number, and location of equipment and outlet.
 - 8. Cable penetration details, schematic riser diagrams, and equipment closet layouts.

- B. Provide as-built drawings to include cabling routing, details of station and hardware locations, etc. The Contractor shall provide as-built drawings on CD disk in AutoCAD (.dwg/.dxf) file format. Contractor will have access to drawings provided with this specification where they are in electronic form.

- C. Provide a set of "As-Built" Drawings encased in a plastic sheet protector at backboard, in each wiring closet.

- D. At the completion of the project, the Contractor shall bring the system wiring diagrams fully up to date with the actual field installation, showing all field-made changes for deviations from the approved shop drawings. Accurately record location of service entrance conduit, termination backboards and cabinets, outlet boxes, messenger cable raceways and cable trays, pull boxes and equipment. Room names and numbers shall be updated to indicate actual field-assigned room numbers. They may not necessarily be the room names and numbers shown on the Contract Drawings.

3.12 RECORDS

- A. All records shall be created by the installation contractor and turned over at the completion of work. The format shall be computer based and both soft copies and hard copies shall be part of the As-built package. The minimum requirements include:

- B. Cable records shall contain a complete listing of the identifier, cable type, length, pair status, pair assignment, termination positions at both ends, manufacturer, and part number.

- C. Connecting hardware records shall contain the identifier, type of hardware and the amount of positions.
- D. Connecting hardware positions records shall contain the identifier, type of position, and the cable identifier attached to it.
- E. Test documentation on all cable types shall be included as part of the As-built package.
- F. Outlet Records: Provide a database of outlet designations capable of being exported to a cable management software system (xls format). The Contractor shall provide a complete database indicating the location of each outlet and corresponding port on wire closet equipment.
- G. Provide a complete Owner's Manual including full documentation of system paths and components to allow for plug and play operating cable management, cable maintenance, and cable modifications. Commercial off-the-shelf manuals shall be furnished for operation, installation, configuration, and maintenance for all products provided as a part of this section.

END OF SECTION 275000

SECTION 275200 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the work of this Section.

1.2 SUMMARY

- A. Provide all materials and labor for the installation of a grounding and bonding system for communications infrastructure. This section includes requirements for providing a permanent grounding and bonding infrastructure for communications circuits, raceways, and cable tray.

- B. Related Sections

- 1. Division 27 Section — "Conduit and Backboxes for Communications Systems"
- 2. Division 27 Section — "Communications Equipment Room Fittings"
- 3. Division 26 Section – Grounding
- 4. Division 26 Section – Lightning Protection
- 5. Division 27 Section – 330 Foot Radio Tower

- C. **Provide and pay for the services of an ETA certified R56 auditor/inspector to provide extensive on-site audit /inspection services for the Motorola R56 grounding compliance.**

- 1. Services shall include on-site pre-installation meetings & pre-construction surveys establish the suitability of a site for communications site installation and required upgrades to meet the industry standards.

- 2. Services shall include periodic on-site installation inspections,

- 3. Services shall include post-installation services.

- 4. R56 Auditor/Inspector shall be a Motorola Solutions National Site Design Team Preferred Service Provider.

5 . Approved R56 auditor / Inspector shall be :

HICAPS, 600 North Regional Road, Greensboro, NC 27409

336-665-1234 Attn: Shiloh Cloninger

1.3 REFERENCES

A. The applicable portions of the following specifications, standards, codes and regulations shall be incorporated by reference into these specifications.

1. General:

- a. National Electrical Code (NEC)
- b. National Electrical Safety Code (NESC)
- c. Occupational Safety and Health Act (OSHA)

2. Communications:

- a. TIA/EIA - 568: *Commercial Building Telecommunications Cabling Standard*
- b. TIA/EIA - 569: *Commercial Building Standard for Telecommunication Pathways and Spaces*
- c. TIA/EIA - 606: *The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings*
- d. TIA/EIA - 607: *Commercial Building Grounding and Bonding Requirements for Telecommunications*
- e. ISO/IEC IS 11801: *Generic Cabling for Customer Premises*
- f. BICSI: *BICSI Telecommunications Cabling Installation Manual*
- g. BICSI: *BICSI Telecommunications Distribution Methods Manual (TDMM)*
- h. BICSI: *BICSI Customer-Owned Outside Plant Design Manual (CO-OSP)*
- i. Proper and thorough grounding and bonding methods in accordance with currently published Motorola R56 standards shall be employed to provide maximum lightning protection.

3. Anywhere low-voltage cabling Standards conflict with electrical or safety Codes, Contractor shall defer to NEC and any applicable

local codes or ordinances, or default to the most stringent requirements listed by either. Knowledge and execution of applicable codes is the sole responsibility of the Contractor. Any code violations committed at the time of installation shall be remedied at the Contractor's expense. Contractor is responsible to bring any perceived conflicts between project documents and referenced Standards or Codes to the attention of (CUSTOMER) for resolution.

1.4 DEFINITIONS

- A. "TMGB" shall mean *Telecommunications Main Grounding Busbar*. There is typically one TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.
- B. "TGB" shall mean *Telecommunications Grounding Busbar*. There is typically one TGB per telecommunications room. The TGB is connected both to the TMGB and to building structural steel or other permanent metallic systems.
- C. "TBB" shall mean *Telecommunications Bonding Backbone*. The TBB is a conductor used to connect TMGBs to TGBs.

1.5 SYSTEM DESCRIPTION

- A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete, permanent Grounding and Bonding infrastructure for communications circuits, raceways, and cable trays as hereinafter specified and/or shown on the Contract Documents. The Grounding and Bonding system shall support an ANSI/TIA/EIA and ISO/IEC compliant communications Structured Cabling System (SCS).
- B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant Grounding and Bonding system.
- C. All grounding and bonding shall be in conformance with manufacturer's requirements for application of warranties provided by the manufacturer as well as be compliant with the current version Motorola R56 grounding requirements.
- D. It is the responsibility of the contractor to be knowledgeable of all previously cited Standards and Codes, including Motorola R56 standards and to bring to the attention of Owner any conflicts or discrepancies to achieve a fully functioning, standards-compliant earthing system.

1.6 SUBMITTAL INFORMATION

- A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Provide product data submittals for all products at the same time.
1. Submit a letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. The letter shall also state that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
 2. For those items noted as allowing "or equal," and which are not being provided as specifically named, submit standard manufacturer's cut sheets or other descriptive information, along with a written description detailing the reason for the substitution.
 3. Provide standard manufacturer's cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.
- B. Shop Drawings:
1. Layout of the grounding and bonding system, specifically for the building(s) or structures included in the contract drawings. Provide AutoCAD scaled shop drawings of site, tower and building.
 - a) Provide shop drawing for interior Halo system
 - b) Provide shop drawing for under raised floor grounding system and dispatch consoles.
 - c) Provide coordination drawings for lightning protection and electrical grounding / surge protection.
 - d) Provide site shop drawing for exterior grounding and bonding.
 2. Installation details of the products to be used in the installation.
 3. Shop drawings showing construction details and locations of components, and description and routing of interconnecting cabling.
 4. Provide shop drawings as required to show compliance with Motorola R56 requirements

- C. Closeout Submittals: Provide submittal information for review as follows:
1. O&M Manual for Communications - At the completion of the project, submit O&M information from product data submittals (above), updated to reflect any changes during the course of construction, to the Designer in the telecommunications-specific O&M Manual for Communications binder labeled with the project name and description.
 2. Records - Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of drawings, specifications and spreadsheets.
 - a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
 - b. Keep Record Drawings at the job site and make available to the Owner and Designer at any time.
 - c. Keep Record Drawings current throughout the course of construction. ("Current" is defined as not more than one week behind actual construction).
 - d. Show identifiers for major infrastructure components on Record Drawings.

1.7 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation Meeting: Installing contractor shall coordinate a site walkthrough with the grounding and bonding manufacturer prior to the start of any work. Manufacturer representative shall provide a pre-installation site report which includes guidance for design changes or confirmation that current site conditions match contract documents.
1. Contractor shall arrange and coordinate on-site meetings with R56 auditor/inspector.
- B. Post-Installation Meeting: Installing contractor shall coordinate a site walkthrough with the grounding and bonding manufacturer at the commencement of work. Manufacturer representative shall provide a post-installation site report to the installing contractor which contains the following:
1. Any deficiencies in the installation or confirmation that the current installation meets the requirements of the standards specified.

2. Electronic markup of the approved shop drawing with embedded images showing all concealed bonding (gas piping, electrical service ground, communication grounds) and a random selection of concealed connections (cable to ground rod, cable to cable, cable to reinforcing steel).
 - a. Photographic documentation shall be provided from the installing contractor to the grounding and bonding manufacturer representative prior to concealing or backfilling.
 - C. Sequencing: Coordinate installation of grounding and bonding system with installation of other building systems and components, including electrical wiring, supporting structures and building materials, and building finishes.
- 1.8 CONTRACTOR WARRANTY:
- A. Provide a Contractor-endorsed complete two-year service warranty against defects in materials and installation and workmanship.
 1. Provide labor attributable to the fulfillment of this warranty at no cost to the Owner.
 2. The Contractor Warranty period shall commence upon Owner acceptance of the work.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials shall consist of busbars, supports, bonding conductors and other incidentals and accessories as required.

2.2 MATERIALS

- A. Grounding/Bonding:
 1. Telecommunications Main Grounding Bus Bar (TMGB):
 - a. Large (20" x 4" x 1/4"), Pre-drilled: CPI 10622-020, or equal
 - b. Small (10" x 4" x 1/4"), Pre-drilled: CPI 10622-010, or equal
 2. Telecommunications Grounding Bus Bar (TGB):
 - a. Large (20" x 4" x 1/4"), Pre-drilled: CPI 10622-020, or equal
 - b. Small (10" x 4" x 1/4"), Pre-drilled: CPI 10622-010, or equal

3. Telecommunications Bonding Backbone: insulated (green in color) copper conductor.
 4. Grounding Conductor: insulated (green in color) copper conductor.
- B. Firestopping material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions.
- C. Labels: As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
1. Hand-carried label maker:
 - a. Brady: ID Pro Plus (or approved equal).
 2. Labels:
 - a. Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)
- D Access Floor Grounding Clamps:
1. Bonds crossed grid conductors to each other, and bonds the access floor pedestals to the conductors.
 2. Specifically designed to bond perpendicular Mesh-BN (a.k.a. MCBN or Mesh Common Bonding Network) conductors per TIA-942-A and TIA-607-B.
 3. Bonds to the pedestal with a single bolt to simplify installation.
 4. Accommodates conductor sizes from #6 – 1/0 AWG, minimizing inventory requirements.
 5. Bonds both round and square access floor pedestals for greater flexibility.
 6. Crossing grounding conductors affixed and bonded using a split bolt quad clamp which requires only one nut to install.
 7. Split bolt design allows easy insertion of perpendicular conductors speeding installation and is UL 467 Listed and CSA
 8. Split bolt is UL Listed and CSA Certified for use up to 600 V and temperature rated 90°C.
 9. Each clamp accepts up to two conductors for a high performance bond with faster installation.

10. Wide wire range-taking capability minimizes inventory requirements.
11. Split-bolt made from high strength, electrolytic bronze to provide reliable grounding connections.
12. Approved Manufacturers for Access Floor Grounding Clamps:
 - a. Panduit or approved Equivalent

E. GROUND RODS

1. Provide 5/8 inch by 10 foot copper clad steel (copper weld) ground rods (typical).
2. Ground rods shall be spaced 15 foot apart. Locations shown on drawings are diagrammatic and only an approximation. Exact type size location and design shall be established on site and determined by the Motorola R56 requirements.
3. Contractor shall provide additional ground rods as required to achieve 5-ohms or less to ground.

F. EXTERIOR GROUND RING

1. Provide compound station ring, #2/0 AWG tinned stranded bare copper wire 30 inches below finished grade or 6 inches below frost line whichever is greater (deeper). Space a minimum of 24 inches from drip edge of building or edge of structure.

G. EXTERIOR GROUND BAR

1. Provide an external minimum of 1/4" x 4" x 24", (36 hole pairs) copper ground bar is to be installed on the outside of the building Tower Equipment Room directly under the main cable entry port and attached with three (3), solid tinned copper, 2-inch ground straps, to the single ground point directly below the main cable entry port. Refer to Harger EPK16MOT)

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.
- B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.
- C. All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.
- D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.
- E. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.
- F. Install the grounding and bonding system in a manner ensuring that communications circuits, when installed, are able to fully comply with the ANSI/TIA/EIA and other references listed in Part 1 — References, above.
- G. Remove surplus material and debris from the job site and dispose of legally.
- H. Grounding and Bonding Conductors:
 - I. 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
 - 2. Install without splices.
 - 3. Support at not more than 36-inch intervals.
 - 4. The grounding and bonding conductor pathway through a plenum shall be in EMT.

a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Division 27 "Conduits and Boxes for Communications Systems," and bond both ends of the conduit to a TGB.

J. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Exothermic welding and listed irreversible high-compression fittings are the only acceptable methods for below-grade bonding. Other types of mechanical connection methods shall not be used below-grade

4. Connections to Structural Steel: Welded connectors.

K. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

3.2 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.

2. Pre-twist the conductor.

3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor.

The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB with Equipment bonding bus conductors shall be 35 mm² csa (#2 AWG) or larger and shall be sized according to Motorola R56 Standard Table S-4.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-C.1 and TIA/EIA-568-C.2 when grounding screened, balanced, twisted-pair cables.

J. Access Floors: Bond all metal parts of access floors to the TGB.

3.3 APPLICATIONS AND INSTALLATION

A. The grounding and bonding infrastructure system shall not make use of the building plumbing system, unless required to do so by the NEC.

1. Coordinate the installation of the grounding and bonding system with the electrical power distribution system grounding infrastructure.

2. Conductors shall be concealed from public view.

B. Ground/Bonding:

1. TMGB: Provide a minimum of one TMGB per telecommunications entrance room for each building and as shown on the Contract Documents. Install TMGB(s) and directly bond TMGB(s) to electrical service ground and to associated TBB(s). Group protector, busbar bonding, and approved building grounding conductors toward one end of the TMGB and leave space for equipment grounding conductors on the other end.

- a) TMGB shall be located in the entrance facility, near the electrical panel to which it will be bonded but installed to maintain clearances required by applicable electrical codes.
 - b) TMGB shall be sized according to the anticipated number of bonded connections needed
 - c) TMGB shall have tinned surface to restrain oxidation and be cleaned and antioxidant paste applied prior to fastening conductors.
 - d) Connectors on TBB which attach to TMGB shall be of two-hole, long-barrel compression lugs of the LCC series as specified in the "Materials" section of this document.
 - e) Building steel within six feet of the communications grounding system should be bonded into the system with appropriate hardware listed in "Materials" section of this document.
 - f) All cables containing a metallic shield or armor shall have that shield properly bonded into the communications grounding system using the appropriately sized Armored Cable Grounding Kit listed in the "Materials" section of this document.
2. TGB: Provide a minimum of one TGB per telecommunications room for each building and as shown on the Contract Documents and as required by the standards, references and codes listed in PART 1 -- REFERENCES above. Directly bond each TGB to its associated TBB and to the nearest building structural steel or other permanent metallic system. Group protector, busbar bonding, and approved building grounding conductors toward one end and leave space for equipment grounding conductors on the opposite end.
 3. TBB(s) and Grounding Conductors: Provide TBB(s) and grounding conductors as shown on the Contract Documents and as required to bond all non-current carrying metal telecommunications equipment and materials to the nearest TGB. Use TBB(s) to connect the TMGB to each TGB. Route along the shortest and straightest path possible with minimal bends. Bends shall be sweeping. Insulate TBB(s) and conductors from their support. TBB(s) and grounding conductors shall be continuous (without splices).
 - a. Ensure that bonding breaks through paint to bare metallic surface of all painted metallic hardware.
 - b. Equipment Grounds ONLY sizing shall be based upon project specification (drawings and notes) for that installation.

Conductors shall be a minimum of 6 AWG and should be sized at 2 kcmil per linear foot of conductor length. Refer to the table below for conductor sizing. These sizes are based on TBB length per TIA 607-B recommendations. Contractor shall bring to the attention of Owner anywhere TBB project specified sizing appears insufficient per the Table below:

Sizing of the TBB	
TBB Length in Linear meters (feet)	TBB Size (AWG)
Less than 4 (13)	6
4-6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10-13 (34-41)	1
13-16 (42-52)	1/0
16-20 (53-66)	2/0
20-26 (67-84)	3/0
26-32 (85-105)	4/0
32-38 (106-125)	250 kcmil
38-46 (126-150)	300 kcmil
46-53 (151-175)	350 kcmil
53-76 (176-250)	500 kcmil
76-91 (251-300)	600 kcmil
Greater than 91 (301)	750 kcmil

c. Note above tables is for Equipment Grounds ONLY. The Ground Bus Conductor for bonding multiple pieces of equipment shall be 35 mm² csa (#2 AWG) or larger and shall be sized according to **Motorola R56 Standard Table S-4.)**

C. Interior System Ground (Halo)

1. Provide an interior system ground (halo) with a single #2 AWG stranded wire with proper connections to the TOWER EQUIPMENT ROOM, Comms Room and other areas as required and in turn, to the tower ground system.
 2. The halo will have a 6-inch break roughly opposite the Master Ground Bar. The #2 AWG ground wire for each row of racks will be suspended on independent ground lead stand offs as outlined in the typical shelter drawing. They will be positioned to ensure the #2 AWG lead is isolated from the main cable racks.
 3. No electrical conduit is allowed to bridge the 6" gap in the halo ground. The internal ground system shall be mounted on the wall using 2-inch (2") standoff insulators, connected to two (2) minimum ¼" x 5"x 24", (33 hole pairs) minimum copper master ground bus bars that are installed directly under each cable entry port.
 4. The ground bus system shall be a Harger EPK16MOT bus bar system or an approved substitute.
 5. The copper ground bars on the back-interior wall of the room(s) will be connected to the corresponding exterior ground bar with stainless steel insulated feed through.
 6. The external ground bar will be connected through a minimum of three (3) 2-inch copper straps to the external building ground ring and tower grounding system. All exterior connections shall be exothermically welded to ensure proper connection. Electrical ground will be bonded to the RF ground.
 7. The Air conditioning units shall be connected to the internal (halo) grounding system only, not to the external equipment shelter grounding system.
- D. Fencing - Grounding for chain link fences and gates.
1. Fences shall be grounded on each side of the gates, at each corner, at the closest approach to each building within 50 feet of the fence.
 2. Grounding locations shall not exceed 150 feet.
 3. Grounding electrodes shall be 1 inch by 10 feet long copper-clad steel rod.
 4. Ground conductor shall be **#2 AWG** (minimum) solid copper wire.
 5. Ground conductor shall be connected to the fence with bronze grounding clamp and to be electrode with exothermic weld to create

electrical continuity between fence posts, fence fabric, and ground rods.

6. Total resistance of fence to ground shall not be greater than 25 ohms.
 7. Substitution Limitations: Soil conditions may dictate the use of a grounding electrode not shown. Installing contractor shall coordinate with lightning protection manufacturer to determine proper materials.
- E. Supplemental Bonding Grid (SBG) (a.k.a. Underfloor Grounding Grids):
1. Provide SBG in all areas with access raised flooring, including PCO and Duty Office. Provide complete underfloor supplemental bonding grids (SBG, a.k.a. underfloor bonding grids), and pathways
 2. Access Flooring system shall be made electrically continuous, with the grid bonded a minimum of every fifth pedestal in each direction as per TIA 607-B Standard, using a minimum size #6 AWG stranded copper conductor and the pedestal clamps listed in the "Materials" section of this document. Specifications for individual R56 radio dispatch projects requiring larger conductor sizes or greater clamp density shall take precedent over these requirements.
 3. Underfloor SBG shall bond to the TMGB or TGB in the computer room with a conductor of 1/0 AWG or larger.
 4. Racks and cabinets shall bond to the SBG with a conductor size of #6 AWG or larger.
 5. Each dispatch console, rack or cabinet will have individual bonding conductors into the grounding grid. Serial connections (or "daisy-chaining") between communications bays is strictly forbidden and will not be accepted.
 6. Power Distribution Units (PDU) shall bond into the Mesh-BN per requirements of NEC 250.122 and per manufacturers' recommendations.
 7. Heating, ventilating and air-conditioning (HVAC) shall have bonding conductors into the underfloor grid of #6 AWG or larger.
 8. Each HVAC unit shall have its own connection and may not be daisy-chained or attached serially.
 9. Each steel column in the communications room shall bond into the Mesh-BN with a conductor of minimum size #4 AWG.

10. All metal cable trays shall be bonded into the grid with a minimum conductor size of #6 AWG or larger. These may be bonded in series.
 11. All metallic conduits, water pipes and air ducts shall be bonded to the grid with a minimum conductor size of 6 AWG or larger. These may be bonded in series.
- F. Bonding within Racks and Cabinets:
1. Racks and Cabinets shall be bonded into the communications bonding network shall be 35 mm² csa (#2 AWG) or larger and shall be sized according to **Motorola R56 Standard** Table S-4.
 2. Depending on size of the telecommunications room, Rack Bonding Conductors (RBC) may tap into underfloor or overhead grounding conductors, or for smaller TRs (3-5 racks or cabinets), may go directly from the rack to the wall mounted busbar.
 3. Racks, cabinets and similar enclosures shall not be attached serially (daisy-chained) but must have individual RBC into the grounding system.
 4. Newly installed racks and cabinets shall have vertical grounding busbars installed along one rail to provide clean bonding landing point for all rack mount equipment. For part numbers vertical busbars see "Materials" section of this document. Grounding busbars shall not be isolated from the rack or cabinet.
 5. All painted components of racks/cabinets shall be assembled using serrated grounding washers and thread-forming screws to ensure electrical continuity between the different structural components of the rack/cabinet.
 6. Larger equipment (chassis switches) with integral grounding terminals or pads shall be bonded to the vertical busbar with equipment grounding kits attached to those terminals and bonding them to the rack-mounted busbars. For kit part numbers see the "Materials" section of this document.
 7. Anywhere two metallic surfaces are to be bonded, contractor shall clean the contact areas of paint or oxidation using abrasive pads, and apply film of anti-oxidation compound between surfaces prior to bonding.
 8. All cable fittings shall be of two-hole (LCC series) compression-type. Mechanical screw-lugs on racking systems will not be accepted and must be removed and replaced at contractor's expense.

9. All screws used to affix compression lugs to rack-mounted vertical busbars shall be of the thread forming type made specifically for electrical bonding.
 10. Smaller equipment (servers, switches) not having integral grounding pads must be bonded to the rack through the equipment mounting flanges using green thread-forming grounding screws with serrations under the head to cut through paint, coatings and oxidation that may be present on the equipment flange. Such equipment shall have minimally one grounding screw per piece of equipment.
 11. ESD (electro-static discharge) ports and wrist straps shall be provided minimally every other rack or bay to be within reach of any active equipment. On larger 4-post racks or cabinets - ESD ports and wrist straps shall be installed on the front and back to be accessible when servicing any active equipment.
 12. As a condition of employment, any internal or contracting technicians servicing active equipment must be wearing a properly grounded wrist strap to dissipate ESD charges prior to touching any (CUSTOMER) active equipment.
- G. Underground Grounding Conductors: Install bare copper conductor, No. 2 AWG minimum.
- H. GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS
- A. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
 - B. Comply with IEEE C2 grounding requirements.
 - C. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches extends above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
 - D. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, bonding conductor. Train conductors level or plumb around corners and fasten

to manhole walls. Connect grounding conductors to cable armor and cable

I. Firestopping

1. Only employees trained/certified by the firestopping manufacturer shall apply firestopping materials.
2. Maintain the fire rating of all penetrated fire barriers. Fire stop and seal all penetrations made during construction.
 - a. Provide firestopping material for through and membrane penetrations of fire-rated barriers.
 - b. Install firestops in strict accordance with manufacturer's detailed installation procedures.
 - c. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in PART 1 – REFERENCES. Apply sealing material in a manner acceptable to the local fire and building authorities.
 - d. For demolition work, apply firestopping to open penetrations in fire rated barriers where cable is removed. Apply firestopping regardless of whether or not the penetrations are used for new cable or left empty after construction is complete.
 - e. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/re-enterable.

J. Labels:

1. Label TMGB(s) with "TMGB"
2. Label TGB(s) with "TGB".
3. Label TBB(s) and bonding conductors "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.4 FIELD QUALITY CONTROL

- A. Independent Testing Organization: Arrange and pay for the services of a qualified independent electrical testing organization to perform tests described below. The system shall be physically inspected by a Nationally Recognized Testing Laboratory (NRTL) to the current edition of ANSI/TIA-607-C. The certification shall be provided to the building owner at the completion of the project.
- B. On installations confined to a single telecommunications room, the installing contractor shall visually verify continuity of communications bonding system from equipment, through racking systems, to overhead or underfloor backbone to the wall mounted busbar in that telecommunications room.
- C. Contractor shall further verify the use of all appropriate bonding accessories in the racking systems such as grounding washers, thread-forming grounding screws and the presence of electrostatic discharge ports and wrist straps within reach of all equipment to be maintained.
- D. On greenfield (new) projects involving installation of a building-wide telecommunications backbone, installing contractor is further responsible for visually verifying sizing and sound installation of the telecommunications bonding backbone including presence of properly sized and installed grounding equalizer conductors between backbones contained in separate risers.
- E. Inspecting Contractor shall verify that any conduit longer than 3 feet through which a grounding conductor passes is properly bonded to the grounding conductor as described in this document.
- F. During inspections contractor shall verify compliance with all stipulations specified in this document and compliance with all regulatory references (Standards and Codes) cited.
- G. All opens or gaps in the bonding system during final inspections will be recorded in the inspection report and remedied.
- H. During inspections, contractor shall check all grounding and bonding system conductors and connections for tightness and proper installation, including checking proper dies were used on compression taps and fittings by checking embossed die numbers on those connections.

- I. Test of 100% of bonded connections within the grounding system with a volt-ohm meter. Resistance tests taken on either side of a compression or exothermic bond shall be less than .2 (2/10) of one ohm in resistance.
- J. Bonded joints to be tested may be random or individually tagged by contractor
- K. Contractor shall Test system at bonded points and provide results in report form.
- L. Provide testing on 100% of exothermic and compression bonds within the installed grounding system.
- M. All bonded connections failing the test described above shall be remedied and retested by the installation contractor at contractor's expense.
- N. Tests and Inspections:
 - 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions
 - 2. Subject the completed grounding system to a megger test at each location where a maximum ground resistance level is specified.
 - 3. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation. a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms
 - 4. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent. a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the

TMGB and in each TGB. Maximum acceptable ac current level is 1 A.

O. Bolting Resistance: Spot test to verify that ground cable bolted connections have a DC resistance of one milliohm maximum, when measured with a bridge type milliohmeter or similar instrument.

P. Continuity: Test grounding conductors, sheet metal, metallic conduits, equipment enclosure, metallic enclosures, and lighting fixtures for continuity to grounding system.

Q. Deficiencies: Where ground resistances exceed specified values, modify the grounding system to reduce resistance values. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Engineer promptly and include recommendations to reduce ground resistance.

R. Grounding system will be considered defective if it does not pass tests and inspections.

S. Prepare test and inspection reports.

T. Provide the services of R56 auditor/inspector to provide on-site field quality control services and document compliance with Motorola R56 requirements for Communications Facility grounding and bonding.

END OF SECTION 275200

SECTION 275800 - CONDUIT AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Provide all materials and labor for the installation of a pathway system for inside plant communications circuits. This section includes requirements for horizontal and building backbone raceways, fittings, and boxes specific to communications circuits (cabling) for voice and data.
- B. Related Sections:
 - 1. Division 27 Section — "Grounding and Bonding for Communications Systems"
 - 2. Division 27 Section — "Inside Plant Communications Systems"

1.3 REFERENCES

- A. Incorporate by reference the applicable portions of the following specifications, standards, codes into this specification section.
 - 1. General:
 - a. National Electrical Code (NEC)
 - b. National Electrical Safety Code (NESC)
 - c. Occupational Safety and Health Act (OSHA)
 - 2. Communications:
 - a. ANSI/TIA/EIA - 568: *Commercial Building Telecommunications Cabling Standard*
 - b. ANSI/TIA/EIA - 569: *Commercial Building Standard for Telecommunication Pathways and Spaces*

- c. ANSI/TIA/EIA - 606: *The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings*
- d. ANSI/TIA/EIA - 607: *Commercial Building Grounding and Bonding Requirements for Telecommunications*
- e. ISO/IEC IS 11801: *Generic Cabling for Customer Premises*
- f. BICSI: *BICSI Telecommunications Cabling Installation Manual*
- g. BICSI: *BICSI Telecommunications Distribution Methods Manual (TDMM)*

1.4 DEFINITIONS

- A. "EMT" shall mean Electrical Metallic Tubing.
- B. "RMC" shall mean Rigid Metal Conduit.
- C. "SMR" shall mean Surface Metal Raceway.
- D. "Raceway" shall mean any enclosed channel for routing wire, cable or busbars.
- E. "TMGB" shall mean *Telecommunications Main Grounding Busbar*. There is typically one TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.
- F. "TGB" shall mean *Telecommunications Grounding Busbar*. There is typically one TGB per telecommunications room. The TGB is connected both to the TMGB and to building structural steel or other permanent metallic systems.
- G. "TBB" shall mean *Telecommunications Bonding Backbone*. The TBB is a conductor used to connect TMGBs to the TGBs.
- H. "Pullbox" shall mean a metallic box with a removable cover, used to facilitate pulling cable through conduit runs longer than 100' or in which there are more than 180 degrees of bends.
- I. "Junction box" shall mean a pullbox wherein a feeder conduit transitions to multiple distribution conduits.

1.5 SYSTEM DESCRIPTION

- A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete Raceway system as hereinafter specified and/or shown on

the Contract Documents. The Raceway system shall support an ANSI/TIA/EIA and ISO/IEC compliant communications Structured Cabling System (SCS) as specified in 271500 - Inside Plant Communications Systems

- B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the Contract Documents but which are necessary to make a complete working Raceway system.

1.6 SUBMITTALS

- A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Provide product data submittals for all products at the same time.

1. Submit a letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. The letter shall also state that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
2. For those items noted as allowing "or equal," and which are not being provided as specifically named, submit standard manufacturer's cut sheets or other descriptive information, along with a written description detailing the reason for the substitution.
3. Provide standard manufacturer's cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.

- B. Closeout Submittals: Provide submittal information for review as follows:
 1. O&M Manual for Communications - At the completion of the project, submit all O&M information from product data submittals (above), updated to reflect any changes during the course of construction, to the College in the telecommunications-specific O&M Manual for Communications binder labeled with the project name and description.
 2. Records - Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of drawings, specifications and spreadsheets, including maintenance hole/handhole butterfly drawings.

- a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
- b. Keep Record Drawings at the job site and make available to the Owner and Designer at any time.
- c. Keep Record Drawings current throughout the course of construction. ("Current" is defined as not more than one week behind actual construction).
- d. Show identifiers for major infrastructure components on Record Drawings.

1.7 CONTRACTOR WARRANTY:

- A. Provide a Contractor-endorsed one-year service warranty against defects in materials and workmanship.
 1. Provide labor attributable to the fulfillment of this warranty at no cost to the Owner.
 2. The Contractor Warranty period shall commence upon Owner acceptance of the work.

1.8 QUALITY ASSURANCE

- A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.
 1. The Terms "Listed" and "Labeled": As defined in NEC, Article 100.
 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. Comply with NECA's "Standard of Installation."
- C. Comply with NEC.

1.9 COORDINATION

- A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials shall consist of conduit, surface metal raceway, outlet boxes, fittings, enclosures, pull boxes, and other raceway incidentals and accessories as required for inside plant communications circuits.

2.2 MATERIALS

A. Conduit:

- 1. EMT. 1" minimum conduit size. Flexible metal conduit (FMC) is not acceptable.
 - a. Conduit: Galvanized steel tubing meeting ANSI C80.3.
 - b. Couplings: Steel, cast iron, or malleable iron compression type employing a split, corrugated ring and tightening nut, with integral bushings and locknuts. Indent-type and setscrew-type couplings are not permitted.
- 2. RMC. 1" minimum conduit size.
 - a. Conduit: Hot dipped galvanized steel with threaded ends meeting ANSI C80.1.
 - b. Couplings: Unsplit, NPT threaded steel cylinders with galvanizing equal to the conduit.
 - c. Nipples: Same as conduit, factory-made up to 8 inches in diameter, no running threads.

B. Sleeves: EMT conduit, with insulated throat bushings for each end

C. Surface Raceway: Wiremold V2400 series or equivalent – Two piece, steel, single channel surface raceway.

D. Outlet boxes: Minimum 4"x4" size, 2 1/8" minimum depth, with extension rings (if needed) and single gang covers (i.e.; mud rings), unless otherwise noted on the Contract Documents. Combined interior depth of outlet box, extension ring and cover shall be a minimum 2-1/2". Stamped steel, deep drawn one piece (without welds or tab connections), galvanized, with knockouts for 1" trade size conduit or connector entrance, meeting NEMA OS 1.

1. Acceptable manufacturers:

- a. Appleton, Raco, Steel City, or equal

2. Wiremold Extra Deep Switch and Receptacle Box: V5744-2 (two gang), or equal
- E. Junction Boxes and Pull Boxes: Stamped steel, deep drawn one piece (without welds or tab connections), galvanized, with knockouts for conduit or connector entrance. Boxes 6"x6"x4" or larger may be code gauge fabricated steel continuously welded at seams and painted after fabrication.
1. Dry locations: meeting NEMA OS 1.
 2. Wet locations: NEMA OS 3R.
- F. Miscellaneous Fittings:
1. Locknuts and conduit bushings: Malleable iron
 - a. Appleton, Crouse Hinds, OZ Gedney, or equal
 2. Through wall seals and floor seals shall be:
 - a. OZ Gedney FS and WS series, or equal.
- G. Pull Strings: Plastic or nylon with a minimum test rating of 200 lb.

2.3 FIRESTOPPING

- A. Material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions.

2.4 LABELING AND ADMINISTRATION

- A. Labels: As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, typed, and created by a hand-carried label maker or an approved equivalent software-based label making system. Handwritten labels are not acceptable.
1. Hand-carried label maker:
 - a. Brady: ID Pro Plus (or approved equal).
 2. Labels:
 - a. Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal).

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.
- B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NEC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.
- C. All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.
- D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.
- E. Install the raceway system in a manner ensuring that communications circuits, when installed, are able to fully comply with the ANSI/TIA/EIA and other references listed in Part 1 — References, above.
- F. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.
- G. Remove surplus material and debris from the job site and dispose of legally.

3.2 EXAMINATION

- A. Examine surfaces and spaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions. Provide a raceway for each location indicated. Do not gang raceway into wireways,

pullboxes, junction boxes, etc., without specific approval from the Designer.

B. Conduit:

1. Install EMT unless other conduit is shown on the Contract Documents or is required by Code.
2. Install conduit as a complete, continuous system without wires, mechanically secured and electrically connected to metal boxes, fittings and equipment. Blank-off unused openings using factory-made knockout seals.
3. Run conduit in the most direct route possible, parallel to building lines. Do not route conduit through areas in which flammable material may be stored.
4. Keep conduit at least 6 inches away from parallel runs of flues and steam or hot-water pipes or other heat sources operating at temperatures above one-hundred degrees Fahrenheit. Install horizontal conduit runs above water piping.
5. Keep conduit away from sources of electromagnetic interference as follows:
 - a. 5 inches from fluorescent lighting
 - b. 12 inches from conduit and cables used for electrical power distribution
 - c. 48 inches from motors or transformers
6. Do not exceed 90 meters total length for a given conduit run to be used for distribution cabling (from outlet box to telecommunications room), including intermediate conduits and junction boxes.
7. Install conduit exposed, except in finished areas or unless shown otherwise on the drawings. Do not install conduit below grade/slab unless specifically shown on the Contract Documents as being installed below grade/slab.
8. Install exposed conduit in lines parallel or perpendicular to building lines or structural members except where the structure is not level. Follow the surface contours as much as practical. Do not install crossovers or offsets that can be avoided by installing the conduit in a different sequence or a uniform line.

- a. Run parallel or banked conduits together, on common supports where practical.
 - b. Make bends in parallel or banked runs from same centerline to make bends parallel.
9. Conduits concealed above ceilings, furred spaces, etc., which are normally inaccessible may be run at angles not parallel to the building lines.
 10. Wherever practical, route conduit with adjacent ductwork or piping and support on common racks. Base required strength of racks, hangers, and anchors on combined weights of conduit and piping.
 11. Where conduits cross building expansion joints, use suitable sliding or offsetting expansion fittings. Unless specifically approved for bonding, use a suitable bonding jumper.
 12. Support conduits as specified in Section "Basic Electrical Materials and Methods."
 - a. Provide anchors, hangers, supports, clamps, etc. to support the conduits from the structures in or on which they are installed. Do not space supports farther apart than five feet.
 - b. Provide sufficient clearance to allow conduit to be added to racks, hangers, etc. in the future.
 - c. Support conduit within three feet of each outlet box, junction box, gutter, panel, fitting, etc.
 13. Ream conduits to eliminate sharp edges and terminate with metallic insulated grounded throat bushings. Seal each conduit after installation (until cable is installed) with a removable mechanical-type seal to keep conduits clean, dry and prevent foreign matter from entering conduits.
 14. Install a pull string in each conduit.
 15. For conduits entering through the floor of a telecommunications room, terminate conduits 6" above the finished floor.
 16. Do not install communications conduits in wet, hazardous or corrosive locations.
 17. Where conduit is shown embedded in masonry, embed conduit in the hollow core of the masonry. Horizontal runs in the joint between masonry units are not permitted.

18. Where conduit is shown embedded in concrete, embed conduit a minimum of two inches from the exterior of the concrete. Do not place conduit in concrete less than 4 inches thick.
 - a. One inch trade size conduit shall be used. Conduits sized smaller than one inch trade size conduit are not permitted embedded in concrete without approval from the College.
 - b. Run conduit parallel to main reinforcement.
 - c. Conduit crossovers in concrete are not permitted.
19. Where conduit exits from grade or concrete, provide a rigid steel elbow and adapter.
20. Where conduit enters a space through the floor and terminates in that space, terminate the conduit at 6" above the finished floor.
21. Where conduits terminate at a cable tray, the conduits shall be consistently terminated no more than 8" from the cable tray, and have a visually uniform appearance.
22. Where several circuits follow a common route, stagger pullboxes or fittings.
23. Where several circuits are shown grouped in one box, individually fireproof each conduit.
24. Bend and offset metal conduit with standard factory sweeps or conduit fittings. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
 - a. Conduit sweeps:
 - 1) Sweeps shall not exceed 90 degrees.
 - 2) Do not exceed 180 degrees for the sum total of conduit sweeps for a section of conduit (between conduit termination points).
 - 3) Sweep radius shall be at least 10 times the internal diameter of the conduit.
 - 4) 90-degree condulets (LB's) and electrical elbows are not acceptable.
 - b. Factory-manufactured sweeps are required for bends in conduit larger than 1-1/4" trade size.

- c. For bends in 1 1/4" trade size conduit and larger, field-manufactured bends (using a hydraulic bender with a 1 1/4" boot) are permitted only when factory-manufactured sweeps are not suitable for the conditions. In all other cases, factory-manufactured sweeps are required. "Hickey-bender" use is prohibited.
25. Connect conduit to hubless enclosures, cabinets and boxes with double locknuts and with insulating type bushings. Use grounding type bushings where connecting to concentric or eccentric knockouts. Make conduit connections to enclosures at the nearest practicable point of entry to the enclosure area where the devices are located to which the circuits contained in the conduit will connect.
26. Penetrations for raceways:
 - a. Do not bore holes in floor and ceiling joists outside center third of member depth or within two feet of bearing points. Holes shall be 1-1/4" diameter maximum.
 - b. Penetrate finished walls and finished surfaces with a PVC or sheet metal sleeve with an interior diameter (ID) at least 1/4" greater than the outer diameter (OD) of the conduit, set flush with walls, pack with fiberglass, seal with silicone sealant.
 - c. Penetrate poured-in-place walls and free slabs with a cast iron sleeve (or Schedule 40 PVC black pipe sleeve for above-grade only) with retaining ring or washer. Set sleeves flush with forms or edges of slab. Pack around conduit with fiberglass and seal with silicone sealant.
27. Raceway terminations and connections:
 - a. Join conduits with fittings designed and approved for the purpose and make joints tight. Do not use set indent-type or screw-type couplings.
 - b. Make threaded connections waterproof and rustproof by applying a watertight, conductive thread compound. Clean threads of cutting oil before applying thread compound.
 - c. Make conduit terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
 - d. Cut ends of conduit square using a hand saw, power saw or pipe cutter. Ream cut ends to remove burrs and sharp ends.

Where conduit threads are cut in the field, cut threads to have same effective length, same thread dimensions and same taper as specified for factory-cut threads.

- e. Provide double locknuts and insulating bushings at conduit connections to boxes and cabinets. Align raceways to enter squarely and install locknuts with dished part against the box. Use grounding type bushings where connecting to concentric or eccentric knockouts.
 - f. Where conduits are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
28. Install conduit sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed conduits, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
- a. Where conduits pass from warm to cold locations, such as the boundaries of air conditioned or refrigerated spaces and where conduits enter or exit buildings from outdoor areas, including underground ducts or conduit runs.
 - b. Where otherwise required by the NEC.
29. Conduit shall be clean and dry.

C. Sleeves:

- 1. Provide sleeves where required, sized as noted on the Contract Documents. Where not noted, sleeve sizing shall be determined by the type and quantity of cable to be routed through the sleeve per TIA/EIA 569A cable capacity standards, plus an additional 20% for future expansion.
- 2. Provide roto-hammering or core drilling where required for installation.
- 3. Seal between sleeve and wall or floor in which the sleeve is installed. Firestop all penetrations to restore wall or floor to pre-penetration fire-rating.

D. Surface Raceway:

1. Provide surface raceway for all surface mounted telecommunications outlet boxes and as shown on the Contract Documents.
2. Surface raceway shall be routed parallel to and perpendicular to surfaces or exposed structural members, and follow surface contours.
3. Surface raceway color shall match as closely as possible the existing wall finish. Do not paint Surface Raceway.
4. Surface raceway systems shall be completely installed, including insulating bushings and inserts as required by manufacturer's installation requirements. Unused openings in the surface raceway shall be closed using manufactured fittings.
5. Surface raceway shall have a minimum two inch radius control at all bend points.
6. Surface raceway shall be securely supported by screws or other anchor-type devices at intervals not exceeding 10 feet and with no less than two supports per straight raceway section. Surface raceway shall be securely supported in accordance with the manufacturer's requirements. Tape and glue are not acceptable support methods.
7. Mechanically and electrically continuous surface raceway shall be bonded and grounded to the Telecommunications Grounding system.

E. Outlet Boxes:

1. Provide outlet boxes and covers as shown on the Contract Documents and as needed. Verify that the appropriate cover type and depth is provided for each type of wall and finish. Provide extension rings as needed.
2. Coordinate box locations with building surfaces and finishes to avoid bridging wainscots, joints, finish changes, etc.
3. Install boxes in dry locations (not wet, corrosive, or hazardous).
4. Attach boxes securely to building structure with a minimum of two fasteners. Provide attachments to withstand a force of one hundred pounds minimum, applied vertically or horizontally.
5. Install boxes at the following heights to the bottom of the box, except where noted otherwise:

- a. Wall mounted telephones: 48" above finished floor.
 - b. Workstation outlets: 18" above finished floor.
 - c. Place boxes for outlets on cabinets, countertops, shelves, and similar boxes located above countertops two inches above the finished surface or two inches above the back splash. Coordinate and verify size, style, and location with the supplier or installer of these items prior to outlet box installation.
6. Recessed mounted outlet boxes:
- a. Recess boxes in the wall, floor, and ceiling surfaces in finished areas. Set boxes plumb, level, square and flush with finished building surfaces within one-sixteenth inch for each condition. Set boxes so that box openings in building surfaces are within one-eighth inch of edge of material cut-out and fill tight to box with building materials. Single gang opening shall extend at least to the finished wall surface and extend not more than 1/8 inch beyond the finished wall surface. Provide backing for boxes using structural material to prevent rotation on studs or joists.
 - b. Install floor boxes level and adjust to finished floor surface.
7. Surface-mounted outlet boxes:
- a. For boxes surface-mounted on finished walls, provide Wiremold outlet box or equivalent. Cut box as necessary to accept conduit.
 - b. For boxes surface-mounted on unfinished walls (i.e. electrical rooms, mechanical rooms), provide 4"x4" (minimum) outlet box with single gang cover.
- F. Floor Boxes:
1. Provide floor boxes as shown on the Contract Documents.
 2. Set device boxes plumb, level, square and flush with floor, within 1/16" tolerance for each condition.
 3. For floor boxes with combined power and telecommunications circuits, provide metal dividers to separate power from telecommunications circuits.
- G. Junction Boxes:

1. Provide junction boxes as shown on the Contract Documents and as required.
 - a. Where sizing is not shown on the Contract Documents, size junction box length and depth according to the size of the feeder conduit in the following table:

Feeder Conduit Size	Box Length	Box Depth
1"	12"	4"
1-1/4"	12"	4"
1-1/2"	12"	4"
2"	24"	4"
2-1/2"	24"	6"
3"	36"	6"
3-1/2"	48"	6"
4"	60"	6"

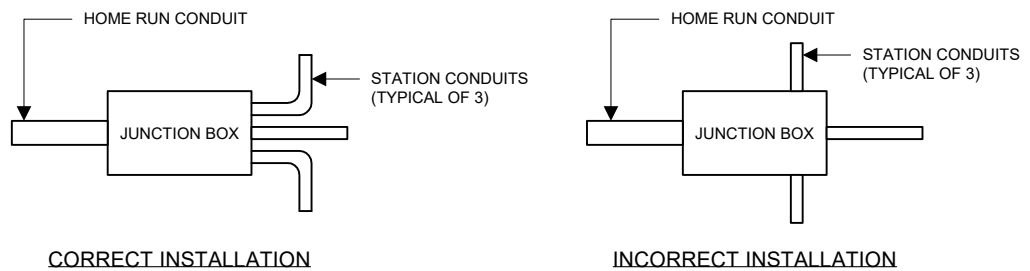
- b. Where sizing is not shown on the Contract Documents, size junction box width according to the following formula:
 - 1) From the table below, select the width associated with the largest conduit on the distribution side of the box. For each additional distribution conduit, add the "Increase Width" value associated with the size of that distribution conduit to the box width for the largest distribution conduit.
 - a) For example, if the distribution side of the junction box has one 1-1/4" distribution conduit and three 1" distribution conduits, the total distribution-side width would be 6"+2"+2"+2"=10".
 - 2) Repeat the above process for the feeder side of the junction box. Junction boxes are typically fed by a single conduit, therefore unless the box has more than one feeder conduit, the "Increase Width" part of the formula is unnecessary.

- a) For example, if the feeder side of the junction box has two 2" feeder conduits the total feeder-side width would be $8''+5''=13''$.
- 3) The larger of the two width calculations (distribution side vs. feeder side) shall be the width of the junction box to be provided.
 - a) For example, if the distribution-side width were 10" and the feeder-side width were 13", provide a 13" wide junction box.

Conduit Size	Box Width	For each additional conduit Increase Width
1"	4"	2"
1-1/4"	6"	3"
1-1/2"	8"	4"
2"	8"	5"
2-1/2"	10"	6"
3	12"	6"
3-1/2"	12"	6"
4"	15"	8"

- 2. A junction box may not be substituted for a 90-degree bend. 90 degree condulets (LB's) are not acceptable.
- 3. Install junction boxes in a location readily accessible both at time of construction and after building occupation. Do not install junction boxes in inaccessible interstitial building spaces.
- 4. Where junction boxes are to be mounted on ceiling structure above ceiling grid, do not mount higher than 4' above grid.
- 5. Install hinged-cover enclosures and cabinets plumb, and supported at each corner.
- 6. Install junction boxes so that the access door opens from the side where the cable installer will normally work – typically from the bottom (floor side) of the box.

- a. Where a junction box is installed in a ceiling space, coordinate with other trades to provide full access to the junction box door and adequate working room for both the installation personnel and for proper looping of cable during installation.
 - b. Provide a lockable access cover (or junction box door if junction box is exposed) in hard lid ceilings.
7. Install junction boxes such that conduits enter and exit at opposite ends of the box as follows:

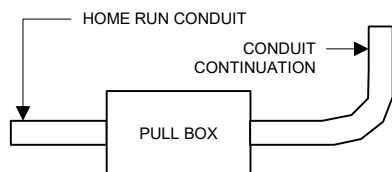


H. Pull Boxes:

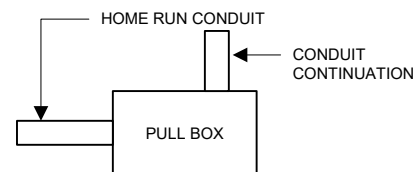
1. Provide pull boxes as shown on the Contract Documents and as required.
 - a. Where sizing is not shown on the Contract Documents, size pull boxes as follows:

Size of Largest Conduit	Box Width	Box Length	Box Depth
1"	4"	12"	4"
1-1/4"	6"	12"	4"
1-1/2"	8"	12"	4"
2"	8"	24"	4"
2-1/2"	10"	24"	6"
3"	12"	36"	6"
3-1/2"	12"	48"	6"
4"	15"	60"	6"

- b. Where a pull box is required with conduits 1" trade size or smaller, an outlet box may be used as a pull box. Where outlet boxes are used as pull boxes, the outlet boxes shall be dedicated for use as a pull box and shall not host cable termination hardware.
2. A pull box may not be substituted for a 90-degree bend. *90 degree condulets (LB's) are not acceptable.*
3. Install pull boxes in an accessible location, readily accessible both at time of construction and after building occupation. Do not install pull boxes in inaccessible interstitial building space.
4. Where pull boxes are to be mounted on ceiling structure above ceiling grid, do not mount higher than 4' above grid (mount on wall instead).
5. Install hinged-cover enclosures and cabinets plumb, and supported at each corner.
6. Install pull boxes so that the access door opens from the side where the cable installer will normally work (typically from the bottom, or floor side, of the box).
 - a. Where a pull box is installed in a ceiling space, provide full access to the junction box door and adequate working room for both the installation personnel and for proper looping of cable during installation.
 - b. Provide a lockable access cover (or pull box door if pull box is exposed) in hard lid ceilings.
7. Install pull boxes such that conduits enter and exit at opposite ends of the box as follows:



CORRECT INSTALLATION



INCORRECT INSTALLATION

- I. Firestopping:

1. Only employees trained/certified by the firestopping manufacturer shall apply firestopping materials.
 2. Maintain fire rating of penetrated fire-rated walls. Firestop and seal each penetration made during construction.
 - a. Provide firestopping material for through and membrane penetrations of fire-rated barriers.
 - b. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures.
 - c. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in PART 1 – REFERENCES. Apply all sealing material in a manner acceptable to the local fire and building authorities.
- J. Grounding/Bonding: Grounding and bonding work shall comply with the Virginia Uniform Statewide Building Code, Uniform Fire Code, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in PART 1 – REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.
1. Bond metallic raceway together and to the nearest TGB (as provided under Division 27 Section — "Grounding and Bonding for Communications Systems"). Ensure that bonding breaks through paint to bare metallic surface of painted metallic hardware.
- 3.4 LABELS:
- A. Conduits: For any conduit extending beyond the space or room in which it starts, label each such conduit end in a clear manner by designating the location of the other end of the conduit (i.e. room name, telecommunications room name, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.). Indicate conduit length on the label.
1. Where a conduit is intended for future cabling use outside of the Contract, the conduit shall be labeled in a clear manner by designating the location of the other end of the conduit (i.e. room name, telecommunications room name, pull box identifier, etc.) along with a sequential number for each spare conduit terminated into a single room. Indicate conduit length on the label.
 - a. Suggestion: The second spare conduit (whether spare or in use) between Room 100 and telecommunications room 1A

might be labeled in the telecommunications room as "Room 100 - #2, __ feet." In Room 100 the same conduit might be labeled "1A - #2, __ feet."

- B. Pull Boxes: Label each pullbox with a unique identifier. Identifiers shall be of the form "RN-Y" where "RN" is the room name of the room closest to (or containing) the pull box, and "Y" is the sequential number of the pull box for each "RN".
 - 1. Example: The second pull box in the vicinity of room "100" would have the label "100-2".
- C. Pull Strings: For any conduit extending beyond the space or room in which it starts, label its pull string in a clear manner by designating the location of the other end of the pull string (i.e. room name, telecommunications room name, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.).
 - 1. Where a pull string is installed in a conduit intended for future cabling use outside of the Contract, the pull string shall be labeled similar to the spare conduit in which it is installed.

3.5 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and in accordance with accepted industry practice, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.6 CLEANING

- 1. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 275800

SECTION 276000 - TELEPHONE AND CATV UTILITY - INCOMING SERVICE PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the General Requirements, apply to the work specified in this section.
- B. Division 16, Basic Materials and Methods sections apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The Contractor shall provide all materials and labor required by the utility for service provisions.
- B. The Contractor shall provide all materials and labor for complete empty conduit power, telephone and CATV distribution systems as shown on the drawings and as specified herein.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. General Electrical Requirements: Div 26
- B. Basic Electrical Materials and Methods: Div 26.
- C. Raceways and Boxes: Div 26.
- E. Underground Ductbanks: Div 26.
- G. Grounding: Div 26.

1.4 UTILITY COMPANY COORDINATION

- A. Contact "Miss Utility" (1-800-257-7777) prior to any excavation or underground work. The Contractor shall verify the location and depth of all utilities. Provide test pits to verify location and depth of all existing utilities crossing new incoming services.
- B. Contact serving utility companies immediately upon award of Contract. Do not install related equipment until fully coordinated with appropriate utilities.

- C. Provide all Construction Schedules, dates of requested services, outage windows, equipment locations, etc., necessary for utility work.
- D. The Contractor shall coordinate the electric and telephone services points of entry to be within twenty (20) feet (7.0 m), or as required to comply with NEC 800-11.
- E. The Contractor shall ascertain, from the utility companies, the exact amount of work required in connection of the utilities. Work required which is not provided by the utility companies shall be provided by the Contractor.
- F. Provide and coordinate all temporary services with utility companies.
- G. The Contractor shall coordinate the required separation distances for all utilities.
- H. The Contractor shall obtain all permits and permissions required.

1.5 SUBMITTALS

- A. Certificate of Compliance: Contractor shall submit a documentation certifying that work complies with all utility company requirements including the following:
 - 1. Construction Standards of each Utility Company.
 - 2. Trench and cover Depth.
 - 3. Spacing and Support of Utilities.
 - 4. Installation of underground marking tape.
 - 5. Pull cords and Mandrels.
- B. Photographs: Contractor shall submit photographs of each utility installation at each of the above described levels of completion and attach photographs to Certificate of Compliance for verification. Submit a minimum of six (6) color 4" x 6" photographs for each utility service.
- C. Submit Certificate of Compliance and photographs to each utility company for verification and approval.
- D. Include Certificate of Compliance, photographs, and utility company approvals in O&M Manual.
- E. The Contractor shall provide and submit all required documentation to each utility company, including service application, site plan and coordination drawings.

1.6 QUALITY ASSURANCE

- A. Comply with the requirements of Power Company **Customer Requirements for Electric Service.**
- B. Comply with the requirements of NFPA 70 National Electrical Code.
- C. Comply with the NECA **Standards of Installation.**
- D. Comply with National Electrical Safety Code.
- E. Contractor shall have experience with not less than 5 comparable projects for which the Contractor completed service provisions with each utility. Contractor shall be familiar with all current utility requirements and guidelines.
- F. Comply with the recommendations and guidelines of **the BICSI Outside Plant Design Reference Manual 5th Edition.**
- G. Obtain utility company inspector's approval for all work.

PART 2 - PRODUCTS

2.1 TELEPHONE COMPANY PROVISIONS

- A. The telephone utility is Verizon.
- B. Telephone Service Wall Space: Provide a wall-mounted 3/4" fire-retardant painted plywood backboard, 8 feet high x 4 feet wide, as shown at location indicated on the drawings.
- C. Provide adjacent to backboard two duplex convenience NEMA 5-20R receptacles connected to the [emergency] power system. Provide 2 #12 and 1 #12 ground in 3/4" conduit from receptacles to nearest 120 volt emergency power panel.
- D. Provide adjacent to the backboard, one No. 8 copper ground conductor extended from the building's service ground point.
- E. Provide one 50 pair telephone cable, plenum rated, (Belden or approved equal by West Penn) run concealed to the Owner's telephone system. Terminate cable in exact location and manner as required.

- F. Provide conduit sleeves where cable is extended through partitions, walls, or floor slabs. Fire seal all openings after cable is installed.
- G. Incoming Telephone service:
1. Coordinate incoming telephone service requirements with area public telephone system utility. Provide two (2) 4" Schedule 40 PVC underground telephone service conduits from the telephone service equipment backboard to the vicinity of the power company's pad-mounted transformers or as indicated on the Drawings and terminate ducts in the exact location and manner as directed by the telephone company.
 2. Provide pre-cast pulling handholes in duct run in location(s) as directed if deemed necessary by the telephone utility. Size of handholes (L x W x H) shall be as required by the utility. Handholes installed in roadways shall be H20 roadway type.
 3. Extend two (2) 4" PVC Schedule 40 underground service conduits along with primary electrical feeder from power company transformer location to 5'-0" beyond property line, or as indicated on the Drawings, then capped and stubbed.
 4. In addition to the above requirements, install raceways in maximum lengths of 300 feet (90m) or as required by telephone company and a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
- H. Coordinate incoming raceway with telephone utility company. Provide required conduit size as determined by the telephone company.
- I. Coordinate for installation of pay telephones. Provide sufficient notice for telephone procurement and installation. Provide all necessary pay telephone rough-in provisions including 1" empty conduit from pay telephone location to main TTB and 120 volt power for ADA-required TTY unit.
- J. Contractor shall be responsible for contacting and coordinating with the telephone company prior to ordering or installing any telephone entrance equipment and provisions.

2.2 CABLE TELEVISION COMPANY PROVISIONS

- A. The Cable Television Company is Comcast.
- B. Incoming CATV Service: Coordinate incoming CATV service requirements with the cable company. Provide two – 4" Schedule 40 PVC underground from the telephone service equipment backboard to the cablevision pedestal in the vicinity of the power company's pad-mounted transformers

as directed by the Cable Company. Extend 2 - 4" Schedule 40 underground service conduit along with primary electrical feeder to 5'-0" beyond the property line, then cap and stub.

2.3 TYPICAL INCOMING SERVICE PROVISIONS

- A. Pull Wire: 1/4" nylon pull cord with 500 lb. minimum tensile strength in each conduit.
- B. Conduit, Elbows, and Couplings: UL Schedule 40, EB-35, DB-60, DB-120, or ANSI/ASTM F-512 as required by utility for the specific application.
- C. Spacers: Every 4 feet of conduit.
- D. Splice Boxes: Purchase from utility company. Provide as required.
- E. Manholes: Purchase from utility company. Provide as required.
- F. Underground Marking: Provide detectable warning tape over all conduits.
- G. Bends: Minimum 5 foot radius (horizontal) and 36" radius (vertical).
- H. Concrete for encasement: Minimum 3,000 psi or as noted on Drawing or as specified in Section 16300 "Underground Ductbank", with air entrainment and pea gravel.
- I. Backfill: Virgin soil/select backfill only. Backfill shall be stone dust, rock-free earth, or top soil with no stones larger than 1-1/2" in diameter permitted.
- J. Miscellaneous Materials: Provide bushings, bell ends, conduit plugs and other miscellaneous materials as required by utility companies.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mandrel: Contractor shall pull a mandrel (1/2" smaller in diameter than the conduit, and six inches long) through each conduit.
- B. Pull Wires: Pull wires shall be left in all conduits, after mandrel pull.

- C. Coordination: Coordinate location of telephone and CATV wall spaces, raceways, and boxes, as necessary, to interface installation of telephone and CATV systems with other work.
- D. Bushings: Provide conduit bushing at each end of all conduits.
- E. Bell Ends & Plugs: Provide Bell ends and plugs for each conduit.
- F. Sealing Conduits: Provide duct sealant in each conduit after utility cable is installed.

3.2 PREPARATION

- A. Contractor shall provide conduits at all street or road crossings for all utility facilities.
- B. Provide a level area at final grade for all transformer, pedestal, and utility equipment locations.
- C. Coordinate utility line separation requirements between electric, water, sewer, gas, telephone and CATV.
- D. Contractor shall clear area for all utility cables of rubble, debris, stumps, and other obstructions.

END OF SECTION 276000

SECTION 280500 - COMMON WORK FOR ELECTRONIC SAFETY AND SECURITY SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Communications equipment coordination and installation.
2. Common communications installation requirements.
3. Demolition
4. Waterproofing.
5. Weatherproofing locations.
6. Cutting and Patching.
7. Painting.
8. Equipment Foundations, Supports, Piers and Attachments.
9. Equipment Guards and Rails.
10. Cleaning, Protecting and Adjusting.
11. Welding.
12. Sleeves for raceways and cables.
13. Sleeve seals.
14. Grout.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.
- C. Wiring: Cable and/or wire installed in Raceway.

1.4 SUBMITTALS

- A. Product Data: For sleeve seals.

1.5 WATERPROOFING

- A. Where work pierces waterproofing, including waterproof concrete, the method of installation shall be approved by the Architect prior to performing the work. Furnish necessary sleeves, caulking and flashing required to make openings absolutely watertight.

1.6 WEATHERPROOFING LOCATIONS (WP)

- A. Communication apparatus, such as outlet boxes, switches, connection panels, speakers, cameras, and other devices shall be weatherproof gasketed type, NEMA Types 3 or 4 in the following instances:
 - 1. On surface of exterior face of building, including areas where not under canopies, cast boxes with threaded hubs must be used and under canopies steel boxes with gasket connections to devices.
 - 2. In any areas where specifically noted "WP" or required by the NEC or Regulations mentioned herein.
 - 3. Within air conditioning enclosures.
 - 4. In underground splice boxes.
 - 5. On building roof.
 - 6. Within vivarium locations.
 - 7. In unconditioned spaces subject to exterior ambient conditions such as loading docks and parking garages.

1.7 CUTTING AND PATCHING

- A. Provide cutting and patching necessary to install the work specified herein. Patching shall match adjacent surfaces. Refer to Division 1, Cutting and Patching for specific directions.
- B. No structural members shall be cut without prior approval of the Architect; such cutting shall be done in a manner directed by him.
- C. Provide ceiling removal and replacement where work above ceilings is required. Replace ceiling components damaged in the process.
- D. Provide patching where communications devices are removed from walls, ceilings or floors.

1.8 ACCESSIBILITY

- A. Coordinate to ensure the sufficiency of the size of shafts, and chases, and the adequacy of clearances in hung ceilings and other areas required for the proper installation of this work.
- B. Locate equipment which must be serviced, operated or maintained in fully accessible positions. Locations in ceilings requiring access shall be coordinated with, but not limited to lights, curtain tracks, and speakers. Equipment requiring access shall include, but is not necessarily limited to, motors, junction boxes, fire dampers, controllers, switchgear, etc.
- C. Indicate the locations of access doors for each concealed device, concealed behind finished construction and requiring service on the coordination drawings. Equipment below floor slab or finished grade shall also be indicated on the coordination drawings.
- D. Furnish access doors under this division for installation by General Contractor. Coordinate during bidding phase with General Contractor. Locations of access doors in finished construction shall be submitted in sufficient time to be installed in the normal course of the work.
 - 1. Manufacturers: Subject to compliance with requirements, furnish access doors by one of the following:
 - a. Bar-Co., Inc.
 - b. J. L. Industries
 - c. Karp Associates, Inc.
 - d. Nystrom, Inc.
 - 2. Materials and Fabrication:
 - a. General: Furnish each access door assembly manufactured as an integral unit, complete with all parts and ready for installation.
 - b. Steel Access Doors and Frames: Fabricate units of continuous welded steel construction, unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of support shown.

- c. Frames: Fabricate from 16-gauge steel.
 - 1) Fabricate frame with exposed flange nominal 1 inch wide around perimeter of frame for units installed in the following construction:
 - a) Exposed Masonry
 - 2) For gypsum drywall or veneer gypsum plaster, furnish perforated frames with drywall bead.
 - 3) For installation in masonry construction, furnish frames with adjustable metal masonry anchors.
 - 4) For full-bed plaster applications, furnish frames with galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
- d. Flush Panel Doors: Fabricate from not less than 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175°. Finish with manufacturer's factory-applied prime paint.
 - 1) For fire-rated units, provide manufacturer's standard insulated flush panel/doors, with continuous piano hinge and self-closing mechanism.
- e. Locking Devices: Furnish flush, screwdriver-operated cam locks of number required to hold door in flush, smooth plane when closed.

1.9 PAINTING

- A. Painting requirements of this section shall conform to Division 9.
- B. Provide surface preparation, priming, and final coat application in strict accordance with manufacturer's recommendations.
- C. Provide prime coat painting for the following:
 - 1. Indoor miscellaneous steel and iron provided under this Division of the specifications.
 - 2. Indoor hangers and supports provided under this Division of the specifications.

1.10 EQUIPMENT FOUNDATIONS, SUPPORTS, PIERS AND ATTACHMENTS

- A. Provide necessary foundations, auxiliary steel, supports, pads, bases and piers required for equipment specified in this division; submit drawings in accordance with Shop Drawing Submittal requirements prior to the purchase, fabrication or construction of same.
- B. Construction of foundations, supports, and pads where mounted on the floor, shall be of the same materials and same quality of finish as the adjacent and surrounding floor material.
- C. Equipment shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and any attachments that are, in the opinion of the Architect, not strong enough shall be replaced as directed, with no additional cost to the Owner.

1.11 CLEANING, PROTECTING AND ADJUSTING

- A. Cleaning
 - 1. General cleaning requirements are specified in Division 1.
 - 2. Upon completion of the work, clean the exterior surface of equipment, accessories, and trim installed. Clean, polish, and leave equipment, accessories, and trim in first-class condition.
- B. Protection of Surfaces
 - 1. Protect new and existing surfaces from damage during the construction period.
 - 2. Provide plywood or similar material under equipment or materials stored on floors or roofs. Provide protection in areas where construction may damage surfaces.
 - 3. Surfaces damaged during the construction shall be repaired or replaced at the cost of the Contractor at fault. The method of repairing or replacing the surface shall be approved by the Owner and Architect.
- C. Protection of Services
 - 1. Protect new and existing services from damage during the construction period.
 - 2. Repair, replace, and maintain in service any new or existing utilities, facilities, or services (underground, overground, interior, or exterior)

damaged, broken, or otherwise rendered inoperative during the course of construction.

3. Services damaged during the construction shall be replaced at the cost of the Contractor at fault. The method used in repairing, replacing, or maintain the services shall be approved by the Owner and Architect.

D. Protection of Equipment and Materials

1. Equipment and materials shall be stored in a manner that shall maintain an orderly, clean appearance. If stored on-site in open or unprotected areas, equipment and material shall be kept off the ground by means of pallets or racks, and covered with tarpaulins.
2. Equipment and material, if left unprotected and damaged, shall be repainted or otherwise refurbished at the discretion of the Owner. Equipment and material is subject to rejection and replacement if, in the opinion of the Architect or the manufacturer's engineering department, the equipment has deteriorated or been damaged to the extent that its immediate use or performance is questionable, or that its normal life expectancy has been curtailed.
3. During the construction period, protect equipment from damage and dirt.

E. Adjusting

1. After the entire installation has been completed, make required adjustments to all systems until performance requirements are met.

1.12 SPECIAL TOOLS

- A. Provide the Owner's representative with two (2) sets of special tools required for operation and maintenance of equipment provided.

1.13 WELDING

A. General Requirements

1. This paragraph covers the welding of systems. Deviations from applicable codes, approved procedures and approved shop drawings shall not be permitted. Materials or components with welds made off the site shall not be accepted if the welding does not conform to the requirements of this specification. Develop and qualify procedures for welding metals included in the work.

- Certification testing shall be performed by an approved independent testing laboratory. Bear costs of such testing.
2. Certified welders, previously certified by test, may be accepted for the work without re-certification provided that all of the following conditions are fulfilled:
 - a. Submit copies of welder certification test records in accordance with this Division and Division 1 requirements.
 - b. Testing was performed by an independent testing laboratory.
 - c. The welding procedures and welders are certified in accordance with the "ASME Boiler and Pressure Vessel Code," and base materials, filler materials, electrodes, equipment, and processes conform to the applicable requirements of this specification.
 - d. Certification has been within a one (1) year period from the start of the project.
 3. Filler metals, electrodes, fluxes and other welding materials shall be delivered to the site in manufacturers' original packages and stored in a dry space until used. Packages shall be properly labeled and designed to give maximum protection from moisture and to assure safe handling.
 4. Submit welding certificates for review. Each welder assigned to work covered by this specification shall be certified by performance tests using equipment, positions, procedures, base metals, and electrodes or bare filler wires.
 5. Before assigning welders to the work, provide the architect with their names, together with certification that each individual is certified as specified. No welding work shall start prior to submissions. The certification shall state the type of welding and positions for which each is certified, the code and procedure under which each is certified, date certified, and the firm and individual certifying the certified tests.
 6. Each welder shall be assigned an identifying number, letter, or symbol that shall be used to identify his welds. A list of the welders' names and symbol for each shall be submitted. To identify welds, either written records indicating the location of welds made by each welder shall be submitted, or each welder shall apply his mark adjacent to his weld using an approved rubber stamp or felt-tipped marker with permanent, weatherproof ink or other approved methods that do not deform the metal. For seam welds, identification marks shall be placed adjacent to the welds at 3 foot intervals. Identification by die stamps or electric etchers shall be confined to the weld reinforcing crown, preferably in the finished crater.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Stainless steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY SYSTEMS INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Coordinate piping systems installed at a required slope.
- F. Apply for detailed and specific information regarding the location of equipment as the final location may differ from that indicated on the drawings. Outlets, equipment or wiring improperly placed because of failure to obtain this information shall be relocated and re-installed without additional expense to the Owner. Determine the actual direction of door swings, so that local switches and other controls shall be installed at the lockside of doors, unless otherwise noted. Improperly located switches shall be relocated without additional expense to the Owner.
- G. The design shall be subject to such revisions as may be necessary to overcome building obstructions. No changes shall be made in location of outlets or equipment without written consent of the Architect and Owner.

- H. Unless otherwise mentioned or indicated, mounting heights of outlets are shown on the drawings or in the specification. Dimensions given shall be considered to be from center of outlet to finished floor.
- I. Coordinate the location and elevation of all communications devices and fixtures with the architectural interior elevation plan and reflective ceiling plan prior to installation.
- J. Properly rough in for the communications raceways and equipment under this contract and modify as required for coordination during the construction period.
- K. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- L. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- M. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 WELDING

- A. Perform welding in accordance with qualified procedures using certified welders. Welding shall not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions. Welding of hangers, supports, and plates to structural members shall conform to AWS specifications.
- B. Field bevels and shop bevels shall be by mechanical means or by flame cutting. Where beveling is by flame cutting, thoroughly clean surfaces of scale and oxidation just prior to welding. Beveling shall conform to ANSI B31.1 and AWS B3.0.
- C. Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening shall not be permitted. Welders responsible for defective welds must be re-certified.
- D. Store electrodes in a dry heated area, keep free of moisture and dampness during fabrication operations. Discard electrodes that have lost part of their coating.

3.3 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY SYSTEMS PENETRATIONS

- A. Electronic Safety and Security Systems penetrations occur when raceways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, fire-rated floor, or wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- F. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- G. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- J. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.4 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 firestopping section.

3.6 DUST, DIRT AND NOISE

- A. Carry out new work and make changes, relocations, and installations with a minimum of noise. Site areas and new equipment, floors and walls, shall be adequately protected from dust and dirt caused by the work. Protection shall include suitable temporary barriers or coverings. The exterior and interior premises of each building shall be kept clean as possible during construction. Damages to surfaces or equipment as a result of negligence shall be replaced or corrected as required.
- B. School activities may be under way during much of the construction period. It is imperative that school functions and activities are given priority and the highest level of respect. Contractor functions which may be excessively noisy or disruptive shall be scheduled for times when school functions will not be interrupted or disturbed.

3.7 ENVIRONMENTAL AIR PLENUMS

- A. In spaces over hung ceiling which are used for environmental air handling purposes as defined by Article 300.22C of the National Electric Code, power data and communications cable must be in conduit or of the type cable rated for air plenum use. Cable type and/or raceway is generally indicated on the drawings and specifications although the Contractor shall be responsible to clearly define ceiling space used for environmental air purposes.

3.8 SPECIAL ENGINEERING SERVICES

- A. In the instance of complex or specialized telecommunications, security, and audiovisual systems that are included in Division 27; the installation, final connections, and testing of such systems shall be made under the direct supervision of competent authorized service engineers who shall be in the employ of the respective equipment manufacturer. Provide the Owner with copies of instruction manuals and booklets for each system and piece of equipment installed. Provide any additional instruction to the Owner over and above the listed above in the care, adjustment, and operation of all parts of the communications systems.

END OF SECTION 280500

SECTION 282300 - SECURITY CAMERA SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division I Specification Sections of the Contract, apply to this Section.

1.2 SUMMARY

- A. This Section includes furnishing of equipment and installation of a CCTV. Contractor shall be responsible for installation and programming of any cameras to this system. Contractor is responsible for the supply and installation of any video input/output cards, switching bay boxes, or any other head end equipment required for a complete system and provide a fully operational CCTV system. The contractor shall provide all wiring, fiber and electrical power, to provide control of pan/tilt/zoom cameras and all CCTV equipment.
- B. The supplier must complete a turn key installation. The supplier shall provide all necessary labor, tools, equipment and material required to furnish and install a complete and fully operational GALAXY Access Control System.
- C. Contractor shall provide the services of a manufacturer authorized installer with experience on other Maryland State Police facility security systems. Provide the services of:

Mobile Communications America (MCA)
Brian Piccolo, Regional Sales Director
410-952-4978 or 410-536-1999 x 107
BrianPiccolo@callmc.com

OR
ABSOLUTE SECURITY GROUP INC
300 Mill St suite a, Salisbury, MD 21801
(410)860-0620
Stephen T. Smith VP
steve@absolutesecuritygroup.com

OR

Approved , Galaxy & Digital Watchdog Certified and qualified equal

1.3 SUBMITTALS

- A. Product Data: Include detailed manufacturer's specifications for each component specified. Include data sheets reflecting the model numbers, features, ratings, performance, power requirements, and dimensions.
- B. Shop Drawings: For CCTV equipment to include plans, elevations, sections, details, and attachments to other Work.
 - 1. Include dimensioned plan and elevation views of components and enclosures. Show access and workspace requirements. Shop drawings shall include mounting details for all wall and pole mounted equipment. Such details shall include all mounting brackets, hardware, and connections to the building and pole structures.
 - 2. Wiring Diagrams: Power, signal, and control wiring point-to-point diagrams. Differentiate between manufacturer-installed and field-installed wiring.
 - 3. It is the Contractors responsibility to submit for approval the complete designed system configuration and layout showing all devices, wiring, conduit, and locations along with other required information as specified herein for the completely integrated system proposed for installation.
- C. Coordination Drawings: Plans drawn to scale and coordinating locations of CCTV equipment. Show the following:
 - 1. Method of attaching hangers to building structure.
 - 2. Location of items requiring installation coordination including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and other architectural features.
- D. Samples: Provide full size samples of each outlet; finish plate, for colors and textures required.
- E. Product Certificates: Signed by manufacturer of CCTV equipment and components certifying that products furnished to the Contractor comply with requirements.
- F. Installer Certificates: Signed by manufacturer certifying that installers comply with manufacturers requirements.
- G. Field Test Reports: Indicate and interpret test results for compliance with performance requirements of installed systems.
- H. Maintenance Data: Maintenance Data for CCTV equipment and

components shall be a part of the maintenance manuals specified in Division 1. In addition to requirements specified, to be provided include the following:

1. Detailed operating instructions covering operation under both normal and abnormal conditions.
 2. Routine maintenance requirements for system components.
 3. Lists of spare parts and replacement components recommended are to be stored at the site for ready access.
- I. Warranties: Special warranties specified in this Section.
- J. Calculations and Parameters; Contractor shall submit for approval, the calculations used and plans and diagrams for the Field of View calculations for the CCTV system. Submission as a minimum shall include and address Low Level Lighting. Backlight compensation, and Lens conformance with this Specification.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: This project requires an experienced installer with a minimum of five (5) years experience installing CCTV equipment and possess manufacturers certification, for both installation and maintenance of equipment required for this Project.
- B. Product Options: Drawings shall indicate size, profiles, and dimensional requirements of surveillance equipment and are based on the specific system indicated. Other manufacturers' products complying with requirements may be considered. Refer to Division I Section "Substitutions."
- C. Electrical Components: Devices, and Accessories; Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 70.
- E. Comply with 47 CFR 15, 17, and 76.
- F. UL Compliance. Comply with applicable requirements of UL safety standards pertaining to television equipment and accessories. Provide TV equipment and accessories, which are UL-listed and labeled.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: System components shall be equipped and rated for the environments where installed
 - 1. Service Conditions for Outdoor Equipment: Rate equipment for continuous operation under the following environmental conditions, unless otherwise indicated:
 - a. Temperature: Minus 15 deg F to plus 122 deg F.
 - b. Relative Humidity: 5 to 100 percent.
 - c. Weather: Enclosure housings to prevent entry of moisture due to melting ice build-up or driven rain or snow.
 - 2. Service Conditions for Indoor Equipment: Rate equipment for continuous operation under the following environmental conditions, unless otherwise indicated:
 - a. Temperature: 32 deg F to 140 deg F.
 - b. Relative Humidity: 0 to 95 percent.

1.6 COORDINATION

- A. Coordinate layout and installation of CCTV surveillance equipment and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

1.7 WARRANTY

- A. Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
 - 1. Special Warranty for Surveillance System and Components: Written warranty, signed by manufacturer and Installer agreeing to correct system deficiencies and replace components that fail in materials or workmanship within specified warranty period when installed and used according to manufacturer's written instructions. This warranty shall be in addition to, and not limiting, other rights Owner may have under other provisions of the Contract Documents.
 - 2. Special Warranty Period: Five years from date of Substantial Completion.
 - 3. Technical Assistance: CCTV equipment manufacturer shall provide a 24-hour technical telephone assistance program, allowing for the communications directly with manufacture employees to answer any questions and resolve problems over the telephone on a 24-hour basis.

4. Repairs: Manufacturer shall provide 24-hour repair and turn around service on all CCTV equipment.

- B. This section applies to security cameras accessories and equipment.

1.8 GENERAL REQUIREMENTS

- A. Design, furnish and install the camera system equipment and layout in conformance with IES recommended procedures. All CCTV system components are to be new, unused products provided with complete Manufacturer's and Contractor's warranty of no less than five years Parts and Labor service. All of the equipment to be furnished is to interface and directly connect to the new headend CCTV equipment. Code converter boxes or translator equipment will not be acceptable.
- B. Lighting: Contractor will assure that adequate area lighting exists to allow for the proper viewing of the video images in the viewing area. This may be accomplished by use of the appropriate combination of cameras, lenses, environmental enclosures, and mounts, as well as, the possible addition of exterior lights. Metal Halide is the preferred exterior lighting source.

1.9 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of each camera with the switching arrangements and provide the Owner with accurate As-built plans within 30 days of contract closeout.

1.10 REFERENCES

- A. Building exterior shall be a mountable surface capable of bearing a shear weight of 100 lbs.

1.11 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years experience.
- B. Security Contractor shall be Digital Watchdog and Axis Certified.
- C. Security Contractor must have one hour response time.
- D. Security Contractor shall be have experience minimum of 5 years of similar installations.

PART 2 - PRODUCTS

2.1 CAMERA EQUIPMENT AND ACCESSORIES

- A. Network Video Server: Provide network video recording server with minimum 160TB RAID 5 16 HDD Dual Redundant Power Supplies. 4U, 6000 Mbps Intel I7 Processor, 16 GB RAM Win 10 OS on Dual SSD (RAID 1). The network video recorder shall provide 30 days of retention of all camera images, at full frame rate (30 frames per second), set to record on motion. Provide Software. NVR shall be **Digital Watchdog Blackjack NVR DW-BJER3U160T**, complete with all licenses,
- B. Power Supply: Each power supply shall provide outputs for exterior camera power.
- C. Interior Fixed vandal resistant Cameras : Each interior color camera shall be recessed and secured to the beam structure of the building or the Owner may opt for corner-mounted or wall-mounted units. All cameras that are recessed will be required to have the domes at ceiling level. It is the Contractor's responsibility to coordinate the camera type and lens requirements with the Owner before the purchase of the cameras as stated in submittals above. The Contractor shall refer to the Camera Schedule and Drawings for installation location and type. The cameras shall be 5 MP **AXIS (P3367-VE)** dome, Digital Watchdog or approved equal.
- D. Exterior Fixed Color Dome Cameras : Each exterior color camera shall be recessed and secured to the beam structure of the building or the Owner may opt for corner-mounted or wall-mounted units. It is the Contractor's responsibility to coordinate the camera type and lens requirements with the Owner before the purchase of the cameras as stated in submittals above. The Contractor shall refer to the Camera Schedule and Drawings for installation location and type. Each exterior camera shall be 4K resolution **AXIS Q3518-LVE** or approved equal.
- E. Multi-Sensor Dome Cameras (Labeled "C3" on Drawings) : Each multi-sensor camera shall be recessed and secured to the beam structure of the building or the Owner may opt for corner-mounted or wall-mounted units. It is the Contractor's responsibility to coordinate the camera type and lens requirements with the Owner before the purchase of the cameras as stated in submittals above. The Contractor shall refer to the Camera Schedule and Drawings for installation location and type. Each exterior camera shall be FOUR 5 MP SENSORS (TOTAL 20 MP RESOLUTION) 4K, resolution **AXIS Q6100-** or approved equal.

- F. Mounts: An appropriate mounting device will be provided at all camera locations to provide a stable and accessible means of access to the camera site. The specifics of each site location will be determined by local considerations at the indicated mounting location during the site walk-through. When domes are mounted to on the roof of buildings, parapet mounts, which incorporate swinging arms for serviceability, shall be provided. Provide wall mount for exterior camera with
- G. CCTV EQUIPMENT CABINET : Two door floor -mounted enclosed metal cabinet arranged to house standard mounting electronic equipment, 21 inches wide, steel shelf enclosure with 16-gauge ends and 18-gauge shelves, six pieces bolted together, with four mounting holes on 16-inch centers for mounting to wall studs. Weight capacity 150 pounds. Finish: Standard black powder coat. Provide fans, grounding bar, door locks, power distribution outlet strip, and all required accessories for a complete installation.
- H. SOFTWARE & LICENSES & INTEGRATION:
1. Provide CCTV software for remote viewing over the network.
 2. Provide Video recording software for archiving on the server.
 3. Provide failover directory server software and keyboard and monitor connection software as needed for a complete system.
 4. Provide 5 client licenses
 5. Provide 1 licenses for each camera.
 6. Provide 5 extra camera licenses for future cameras.
 7. Provide system integration with Galaxy access control system.
- I. MONITORS : Provide two LCD flat screen 42" security displays in Reception Room. Provide tilt wall mount bracket . Provide one 19"LCD flat screen display in the equipment rack. Provide rack mount for display.
- 2.2 SPLICES, TAPS
- A. All splices underground; in hand holes or other wet locations shall be waterproof and made with Scotch-cast 85 Multi-Mold Splicing Kits, or approved equal.
- B. All taps shall use suitable connectors such as Burndy Type Ks and taped with two layers of 3M Scotch Brand or approved equal rubber tape and six layers of vinyl plastic electrical tape.
- C. Splices in hand holes shall be supported on bricks 8 inches above the bottom of the hand hole. Splices shall be kept to a minimum.

2.3 CABLING

- A. Provide Camera network Plenum Category 6 cabling homerun to IT closet and terminated with the rest of the network cabling on patch panel.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Examine adjacent surfaces to determine that surfaces are ready to receive work.
- B. Examine each piece of equipment to determine suitability for location specified.

3.2 INSTALLATION

- A. Install camera equipment and accessories in accordance with manufacturer's instructions.
 - 1. Install equipment in consoles and EIA Standard 19" Equipment Racks.
 - 2. Connect equipment to the branch circuits and cables provided by Contractor.
 - 3. Bond products and metal accessories to the branch circuit equipment-grounding conductor.
- B. Equipment shall be located clear of equipment that will affect the field of view of the cameras. The Owner reserves the right to relocate any camera within 15 feet from locations shown on drawings at no cost to the Owner.
- C. Open trenches shall not exceed 30 linear feet before backfilling. All trenching shall conform to National Safety Standards. Contractor shall be responsible for traffic control, backfilling, asphalt or concrete repairs to the roadway, driveways, or sidewalks. No trench shall be left open overnight. It is the contractor's responsibility to provide any steel plates to maintain traffic and vehicle access each day at job shutdowns. Contractor is also responsible for locating any utilities before trenching or digging begins.

3.3 ADJUSTING AND CLEANING

- A. Adjust equipment as directed by the Owner.
- B. Clean paint splatters, dirt, and debris from installed equipment.

- C. Touch up enclosures, buildings, and interior finish at completion of work.
- D. Replace equipment and mounts, which have failed at completion of work.

3.4 COORDINATION

- A. Confirm compatibility and interface of other materials with CCTV system. Report discrepancies to the Owner.
- B. Supply trim rings, back boxes, etc., to other trades as necessary.
- C. Coordinate with the Mechanical, and Structural Contractors to avoid conflicts between cameras, supports, fittings, and mechanical equipment.
- D. Before ordering, confirm construction details and architectural finish for each area with the Owner.

3.5 FIELD COMMISSIONING AND CERTIFICATION

- A. Field Commissioning: Test video management system as recommended by manufacturer, including the following:
 - 1. Conduct complete inspection and testing of equipment, including verification of operation with connected equipment.
 - 2. Test devices and demonstrate operational features for Owner's representative and authorities having jurisdiction, as applicable.
 - 3. Correct deficiencies until satisfactory results are obtained.
 - 4. Submit written copies of test results.
- B. Pretesting:
 - 1. After installation, align, adjust, and operate the system to assure proper operation of all features and controls.
 - 2. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications.
 - 3. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved.
 - 4. Prepare forms for systematic recording of acceptance test results.
- C. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of the witnesses to the preliminary tests.

- D. Minimum System Tests: Test the system according to the manufacturer's recommended procedures. Minimum required tests are as follows:
1. System is free from grounded or open circuits.
 2. System has no interference or anomalies that affect picture quality.
 3. Each camera functions properly under all conditions encountered at the location including, daylight, artificial light, weather, etc.
 4. Camera displays indicate titling as directed by owner for each view.
 5. All video monitors display camera views properly and are fine tuned for picture quality.
 6. Video recording and playback equipment functions properly.
 7. Camera controls and video display controls function properly for image scanning, split screen, etc.
 8. Video devices function as specified and produce picture quality in compliance with specification.
 9. Any test such as loss of power supplies, will initiate the proper system response in compliance with specification.
- E. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

3.6 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch up, repair or replace damaged products before Substantial Completion.

3.7 DRAWINGS:

- A. The contractor shall furnish three (3) copies of all plans, drawings and schematics to the owner after the acceptance test. The drawings shall show all terminal designation, location of all cameras, control equipment, junction boxes, terminal cabinets, devices, wiring and conduit routings.

3.8 WARRANTY AND SERVICE

A. Warrant the equipment and wiring free from electrical and mechanical defects for a period of TWO years from the date of Owner's acceptance of system.

B. The Contractor shall employ a factory-trained service organization within 50 miles of the job site. This organization shall have a minimum of seven (7) years experience in servicing Integrated CCTV Surveillance Systems and equipment.

C. Fully qualified repair and maintenance personnel shall be available on a twenty-four (24) hour a day basis, three hundred and sixty-five (365) days a year, with four (4) hour maximum response time for service.

D. Normal service shall be defined as minor repairs and/or adjustments. Service of this nature shall be provided at no cost to the Customer during normal business hours, which are between 8:00AM and 5:00PM, Monday through Friday. For service calls requested by phone before 11:00 AM on a weekday, service shall occur on a same-day basis.

E. Emergency service shall be required for emergencies defined as critical equipment not being functional, and shall be furnished at no cost to the Customer during the warranty period. Emergency service shall respond within a four (4) hour period, twenty-four (24) hours per day, three hundred and sixty-five (365) days a year. A list of critical equipment shall be developed and coordinated by the Customer and the Contractor.

3.9 ACCEPTANCE

A. Contractor shall demonstrate to the satisfaction of the Owner that all equipment is operating properly. Any faulty equipment shall be replaced at the Contractor's expense. The Contractor shall demonstrate operation of all installed equipment.

END OF SECTION - 282300

SECTION 283111 FIRE ALARM SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Sections and Divisions apply to this Section:
 - 1. Section 08710, Electro-magnetic Door Holders.
 - 2. Section 230300, Automatic Sprinkler System
 - 3. Section 230975, Direct Digital Control Systems
 - 4. Section 260010, Basic Electrical Requirements.
 - 5. Section 260050, Basic Electrical Materials and Methods.
 - 6. Section 260110, Raceways.
 - 7. Section 260120, Low Voltage Wire and Cable.
 - 8. Section 260135, Boxes and Cabinets.
 - 9. Section 260195, Electrical Identification.

1.2 SUMMARY

- A. This Section includes fire alarm systems. It includes requirements for system components including but not limited to the following:
 - 1. Peripheral Alarm Initiation Devices:
 - a. Manual stations.
 - b. Smoke detectors.
 - c. Duct detectors.
 - d. Heat detectors.
 - e. Duct smoke detectors with associated duct smoke detector test station.
 - f. Waterflow and waterflow tamper switches dry contacts.
 - 2. Peripheral Alarm Indicating Devices
 - a. Visual alarm signals.
 - b. Voice alarm speakers.
 - c. Combined visual signal and voice alarm.
 - 3. Control Devices:
 - a. Addressable interface units and relays for:
 - 1) Annunciators.
 - 2) Emergency power supply.
 - 3) Electro-magnetic door holder (door release) releases.

- 4) Electro-magnetic door lock (door release) releases
- 5) Fan shutdown.

1.3 DEFINITIONS

- A. Alarm Initiating Device: A manual station, smoke detector, heat detector, or sprinkler water flow switch.
- B. Alarm Signal: Signifies a state of emergency requiring immediate action. Pertains to signals such as the operation of a manual station and the operation of a sprinkler system flow switch.
- C. Class A Wiring: Circuits arranged and electrically supervised so a single break or single ground fault condition will be indicated by a trouble signal at the FACP and the circuit will continue to be capable of operation for its intended service in the faulted condition no matter where the break or ground fault condition occurs.
- D. Class B Wiring: Circuits electrically supervised such that a single break or a single ground fault condition will be indicated by a trouble signal at the FACP no matter where the break or ground fault condition occurs.
- E. Hard-Wired System: Alarm, supervisory, and initiating devices directly connected, through individual dedicated conductors, to a central control panel without the use of multiplexing circuits or devices.
- F. Multiplex System: One using signaling method characterized by the simultaneous or sequential transmission, or both, and the reception of multiple signals in a communication channel, including means for positively identifying each signal.
- G. Supervisory Signal: Indicates need for action regarding fire suppression or other protective system.
- H. Trouble Signal: Indicates that a fault, such as an open circuit or ground, has occurred in the system.
- I. Zone: Initiating device or combination of devices connected to a single alarm initiating device circuit.

1.4 SYSTEM DESCRIPTION

- A. General: Zoned, noncoded, addressable, microprocessor based type system with manual and automatic alarm initiation, analog addressable smoke detectors, and automatic alarm verification for alarms initiated by certain smoke detector zones as indicated.

- B. Signal Transmission: Multiplex signal transmission dedicated to fire alarm service only.
- C. Audible Alarm Indication: By voice alarm messages and tone signals on loudspeakers.
- D. System connections for alarm initiation and alarm indicating circuits: Class A wiring.
- E. Functional Description: Provide a complete fire alarm and detection system with the following functions and operating features:
 - 1. Noninterfering: Provide zoned, powered, wired, and supervised system so a signal on one zone does not prevent the receipt of signals from any other zone. All zones shall be manually resettable from the FACP after the initiating device or devices have been restored to normal. Systems that require the use of batteries or battery backup for the programming function are not acceptable.
- F. Signal Initiation: The manual or automatic operation of an alarm initiating or supervisory operating device shall cause the FACP to transmit appropriate signals including:
 - 1. General alarm.
 - 2. Smoke detector alarm.
 - 3. Fire suppression system operation alarm.
 - 4. Valve tamper supervisory.
 - 5. Door release.
 - 6. Fan shutdown.
- G. Transmission to Remote Central Station: Interface with monitoring companies monitoring module device. Monitoring company is contracted directly by owner.
- H. Silencing at FACP: Switches shall provide capability for acknowledgment of alarm; supervisory, trouble, and other specified signals at the FACP; and capability to silence the local audible signal and light an LED (light emitting diode). Subsequent zone alarms shall cause the audible signal to sound again until silenced in turn by switch operation. Restoration to normal of alarm, supervisory, and trouble conditions shall extinguish the associated LED and cause the audible signal to sound again until the restoration is acknowledged by switch operation.
- I. Power Loss Indication: Sound trouble signal at the FACP upon loss of primary power at the FACP and the annunciator. Illuminate the emergency power light at both locations when the system is operating on the emergency generator.
- J. Annunciation: Annunciate manual or automatic operation of any alarm or supervisory initiating device both on the FACP and on the annunciator indicating the location and type device.
 - 1. FACP Alphanumeric Display: Alphanumeric display.

- K. General Alarm: A system general alarm includes:
1. Indicating the general alarm condition at the FACP and the system annunciator.
 2. Identifying the device that is the source of the alarm (or its zone) at the FACP and the system annunciator.
 3. Initiating visible alarm signals.
 4. Initiating voice alarms.
 5. Releasing the front entry door electro-mechanical lock.
 6. Releasing all door magnetic hold open devices.
 7. Stopping supply and return fans serving zone where alarm initiated.
 8. Closing smoke dampers and combination fire/smoke dampers on system serving zone where alarm initiated.
 9. Initiating transmission of alarm signal to remote central station.
 10. Manual station alarm operation initiates a general alarm.
 11. Water flow alarm switch operation:
 - a. Initiates a general alarm.
 - b. Causes the device location indicating lamp of the device that has operated to flash.
 12. Smoke detection initiates a general alarm.
 13. Smoke Detection for a Zone with Alarm Verification Causes:
 - a. Audible and visible indication "alarm verification" signal at the FACP.
 - b. Activation of a listed and approved "alarm verification" sequence at the FACP and the detector.
 - c. General alarm initiation if the alarm is verified.
 - d. FACP indication canceled and system reset if the alarm is not verified.
 14. Sprinkler valve tamper switch operation:
 - a. Causes a supervisory audible and visible "valve tamper" signal indication at FACP and annunciator.
 - b. Causes location indicating light to flash for the device that has operated.
 - c. Initiates transmission of supervisory signal to remote central station.
 15. Activation of local detectors associated with the following devices shall cause these devices to operate through detector base auxiliary relays:
 - a. Smoke dampers and combination fire smoke dampers.
 16. Activation of the kitchen hood fire suppression system shall cause:
 - a. Initiates a general alarm.
 - b. Operation of audible and visual alarms.
 - c. Closing of associated gas valves and trip of associated shunt trip breakers.
 - d. Starting of associated kitchen exhaust fan.
- L. Activation of SEPARATE auxiliary system bypass switches shall override the automatic functions selectively within the system for:

1. Transmission of fire alarm condition signal to the municipal fire department (fire command station).
 2. Operation of audible and visual alarms.
 3. Operation of visual alarms.
- M. Remote Detector Sensitivity Adjustment: Manipulation of controls at the FACP causes the selection of specific addressable smoke detectors for adjustment, displays of their current status and sensitivity settings, and controls changes in those settings. Provide ability of using the same controls to program repetitive scheduled changes in sensitivity of specific detectors. Sensitivity adjustments and sensitivity adjustment schedule changes shall be printed on the system printer.
- N. Permissible Signal Time Elapse: The maximum permissible elapsed time between the actuation of any fire alarm or fire detection system alarm initiating device and its indication at the FACP is ten seconds.
- O. Independent System Monitoring: Supervise each independent smoke and heat detection system, duct detector, and elevator smoke detection system for both normal operation and trouble.
- P. Circuit Supervision: Indicate circuit faults with both a zone and a trouble signal at the FACP. Provide a distinctive indicating audible tone and (LED) indicating light. The maximum elapsed time between the occurrence of the trouble condition and its indication at the FACP is 200 seconds.
- Q. Shall be provided with two-way communication system for each second floor area of refuge and each elevator landing.

1.5 ZONES

- A. Smoke/Fire Zones: The building shall be group zoned according to the smoke partition construction with further breakdown as to the device type. Refer to Drawings for complete description of designated fire alarm zones. Fire alarm shall match the fire sprinkler zones.

1.6 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for fire alarm system components including dimensioned plans, sections, and elevations showing minimum clearances, installed features and devices, and list of materials and NRTL listing data. Itemize catalog cuts and specification sheets by Contract Drawing symbols.

- C. Wiring diagrams from manufacturer differentiating between manufacturer-installed and field-installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Include drawings indicating components for both field and factory panel wiring.
- D. Shop drawings detailed drawings of all annunciators.
- E. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs. Description shall cover this specific project. Manufacturer's standard descriptions for generic systems are not acceptable.
- F. Calculations for battery capacity for both alarm and supervisory modes.
- G. Provide nameplate and encased code directory submittals.
- H. Operation and maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1 and in Section 260010 - Basic Electrical Requirements. Operation and maintenance data shall cover each type of product, including all features and operating sequences, both automatic and manual. Provide spare parts data. Provide the name, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be furnished.
- I. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with the referenced standards.
- J. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make a simultaneous identical submission to the authority having jurisdiction. Include copies of annotated Contract Drawings as required to depict component locations to facilitate review. Upon receipt of comments from the authority, submit a copy of the marked-up submittal for review. Make resubmissions to the authority if required to make clarifications or revisions to obtain approval.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who is a factory-authorized service representative to perform the Work of this Section.
 - 1. The equipment manufacturer shall have a local branch office with engineering and service departments staffed with trained, full-time employees capable of testing, inspection, repair and maintenance services for the life of the fire alarm system.
 - 2. The equipment supplier shall make available to the Owner, the services of an authorized representative of the manufacturer to train facility maintenance personnel in the operation, programming and routine maintenance of the system.
 - 3. The equipment supplier shall represent a major fire alarm equipment manufacturer

and shall conform to and provide proof of the following:

- a. Has represented the equipment manufacturer for a minimum of three years in the project area.
 - b. Has a local shop with all testing equipment and a complete local stock of replacement parts and materials for servicing the equipment supplied.
 - c. Has emergency service for servicing equipment after normal working hours.
 - d. Has suitable finances to provide the work indicated and the guarantee required, and to provide future service on the equipment under contract or on-call basis.
 - e. Has trained, full time employees to provide necessary testing, inspection, repair and maintenance of the system.
- B. Compliance with Local Requirements: Comply with the applicable building code, local ordinances, and regulations and the requirements of the authority having jurisdiction.
- C. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- D. NFPA Compliance: Provide fire alarm and detection systems conforming to the requirements of the following publications:
1. NFPA 70
 - a. NEC Article 725 - Class 1, 2 and 3 Signaling Circuits.
 - b. NEC Article 760 - Fire Protective Signaling Systems.
 2. NFPA 72 – National Fire Alarm Code.
 3. NFPA 101 - Life Safety Code.
- E. UL Listing and Labeling: Provide system and components specified in this Section that are listed and labeled by UL and specific references as follows
1. UL 38 Manually Actuated Signaling Boxes.
 2. UL 217 Smoke Detectors, Single and Multiple Station.
 3. UL 268 Smoke Detectors for Fire Protective Signaling Systems.
 4. UL 268A Smoke Detectors for Duct Applications.
 5. UL 464 Audible Signaling Appliances.
 6. UL 521 Heat Detectors for Fire Protective Signaling Systems.
 7. UL 864 Control Units for Fire Protective Signaling Systems.
 8. UL 1481 Power Supplies for Fire Protective Signaling Systems.
- F. Nationally Recognized Testing Laboratory Listing and Labeling (NRTL): Provide system and components specified in this section that are listed and labeled by an NRTL. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.
- G. FM Compliance: Provide fire alarm systems and components that are FM-approved.

- H. Single-Source Responsibility: Obtain fire alarm components from a single source who assumes responsibility for compatibility for system components furnished.

1.8 MAINTENANCE SERVICE

- A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months commencing with Substantial Completion, using factory-authorized service representatives.
- B. Basic services: Systematic, routine maintenance visits on a monthly basis at times coordinated with the Owner. In addition, respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.
- C. Additional Services: Perform services within the above 12-month period not classified as routine maintenance or as warranty work as described in Division 1 Section "Warranties and Bonds" when authorized in writing. Compensation for additional services must be agreed upon in writing prior to performing services.
- D. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the maintenance services contract, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional one-year term. Owner will be under no obligation to accept maintenance service contract renewal proposal.

1.9 EXTRA MATERIALS

- A. General: Furnish extra materials matching products installed, as described below, packaged with protective covering for storage, and identified with labels clearly describing contents.
- B. Glass Rods for Manual Stations: Furnish quantity equal to 15 percent of the number of manual stations installed; minimum of 6 rods.
- C. Control Unit - Furnish quantity equal to 10 percent of the number of units installed, but not less than one.
- D. Manual Pull Station and tamper cover - Furnish quantity equal to 10 percent of the number of units installed, but not less than one.
- E. Lamps for Remote Indicating Lamp Units: Furnish quantity equal to 10 percent of the number of units installed, but not less than one.
- F. Lamps for Strobe Units: Furnish quantity equal to 10 percent of the number of units installed, but not less than one.

- G. Smoke Detectors, Fire Detectors, and Flame Detectors: Furnish quantity equal to 10 percent of the number of units of each type installed but not less than one of each type.
- H. Detector Bases: Furnish quantity equal to 2 percent of the number of units of each type installed but not less than one of each type.
- I. 1 spare fuse for each fused circuit in the system
- J. 3 sets of any special tools required.
- K. 24 spare screws of each type installed.
- L. 2 screwdrivers of each type needed for system repairs/maintenance.
- M. Keys and locks for all equipment shall be identified and identical where possible. Not less than 12 keys for each type required shall be provided. A key numbering chart shall be provided in each instruction manual furnished.
- N. Allowances: General: Provide in the bid an allowance to install seven additional initiation and alarm signaling devices of each type, operational and complete in every manner, including but not limited to: device, raceway, wiring, concealment, accessory components, power supplies of all types, and programming. Any devices not installed under this allowance shall be provided as additional spare stock in addition to the specified spare stock. Include allowance devices in power supply and battery calculations as an additional spare capacity.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products and series type indicated by the following:
 - 1. GE
 - 2. Notifier; Div. of Pittway Corp.
 - 3. Silent Knight
 - 4. Fire-Lite Alarms

2.2 MANUAL PULL STATIONS

- A. General: Double-action type, fabricated of metal or plastic, and finished in red with molded raised letter operating instructions of contrasting color. Stations requiring the breaking of a glass panel are not acceptable. Stations that require the breaking of a concealed glass rod shall be provided.

- B. Reset: Key-operated reset station switch, double pole, double throw, and rated for the voltage and current at which they operate. Provide stations with screw terminals for connections.
- C. Protective Shield/Cover: Provide a tamperproof, clear LEXAN shield and red frame that easily fits over manual pull stations. When shield is lifted to gain access to the station, a battery powered piercing warning horn shall be activated. The horn shall be silenced by lowering and realigning the shield. The horn shall provide 85dB at 10 feet and shall be powered by a 9 VDC battery.

2.3 SMOKE DETECTORS

- A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Provide the following features:
 - 1. Factory Nameplate: With serial number and type identification.
 - 2. Operating Voltage: 24-V d.c., nominal.
 - 3. Self-Restoring: Provide detectors that do not require resetting or readjustment after actuation to restore them to normal operation.
 - 4. Plug-in Arrangement: Detector and associated encapsulated electronic components mounted in a module that connects to a fixed base with a twist-locking plug connection. The plug connection shall require no springs for secure mounting and contact maintenance. Provide terminals in the fixed base for building wiring.
 - 5. Visual Indicator: Connected to indicate detector has operated.
 - 6. Addressability: Provide detectors with a communication transmitter and receiver having a unique identification and status reporting capability to the FACP.
 - 7. Remote Controllability: Provide detectors individually monitorable at the FACP for calibration, sensitivity, and alarm condition, and have capability of individually adjustable sensitivity from the FACP.
 - 8. Photoelectric Smoke Detectors: Include the following features and characteristics:
 - a. Detector Sensitivity: Between 2.5 and 3.5 percent per foot smoke obscuration when tested in accordance with UL 268.
 - b. Sensor: Infrared detector light source with matching silicon cell receiver.
 - c. 135 degrees F back-up element.
 - 9. Ionization-Type Smoke Detectors: Multiple-chamber-type operate on the ionization principle and actuated by the presence of invisible products of combustion.
- B. Duct Smoke Detector:
 - 1. Photo-electric detector with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Complete with housing and relay as required for fan shutdown.

2. Duct Smoke Detector Indicator and Test Station:
 - a. Flush wall mounted except surface wall mounted or group wall mounted or grouped flush door mounted in mechanical equipment rooms.
 - b. Alarm/power LED.
 - c. Keyed test switch.
 - d. Stainless steel faceplate.
 - e. White lettering on red nameplate identifying associated duct smoke detector.

- 2.4 HEAT DETECTORS: Combination rate-of-rise and fixed-temperature type with plug-in base and alarm indication lamp. Provide detectors with a communication transmitter and receiver complete having a unique identification and status-reporting capability to the FACP.

- 2.5 WATERFLOW SWITCHES: Provided by Division 23, wired by Division 26. Provide control modules as required.

- 2.6 SPRINKLER VALVE TAMPER SWITCHES: Provided by Division 23, wired by Division 26. Provide control modules as required.

- 2.7 ALARM INDICATING DEVICES
 - A. General: Equip alarm indicating devices for mounting as indicated. Provide terminal blocks for system connections.

 - B. Addressable Interface Units: Unit designed to monitor system component not equipped for multiplex communication with FACP and transmit identification and status to that terminal. Provide units with a communication transmitter and receiver complete having a unique identification and status-reporting capability to the FACP.

 - C. Visual Alarm Signals: Strobe lights utilizing high-intensity, clear, optic polycarbonate lens and xenon flash tube. Provide the word "FIRE" engraved in minimum 1-inch-high letters displayed on the unit. Wall mount models shall be red with white "FIRE" lettering. Ceiling mount models shall be red with white "FIRE" lettering on three sides. Units shall be UL listed to Standard 1971 and be ADA compliant. Units shall have field adjustable intensities of 15, 30, 75, and 110 Candela. Reflector shall be design for light output in key axis directions appropriate to the mounting configuration. Provide synchronized flashing utilizing synchronization modules. Strobe leads shall be factory- connected to screw terminals. Units shall be ADA compliant.

 - D. Voice/Tone Speakers: Comply with UL 1480, "Speakers for Fire Protective Signaling."

- E. Speakers: Compression-driver type with flared projectors having a frequency response of 400 to 5000 Hz.; equipped with an alnico V magnet and a multiple tap, varnish impregnated, sealed matching transformer. Transformer tap range and speaker power rating shall be matched to the acoustical environment of the speaker location.
- F. High-Range Speaker Units: Rated 2-15 watts.
- G. Low-Range Speaker Units: Rated 1-2 watts.
- H. Speaker Mounting: Flush or surface mounted as shown on Drawings.

2.8 FIRE ALARM CONTROL PANEL (FACP)

- A. General: Comply with UL 864, "Control Units for Fire Protective Signaling Systems."
- B. Cabinet: Lockable steel enclosure. Arrange panel so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control panel, provide exactly matching modular unit enclosures. Provide cabinets large enough to accommodate all components and to allow ample gutter space for interconnection of panels as well as field wiring. Identify each enclosure and each component by an engraved red laminated phenolic resin nameplate. Lettering on the enclosure nameplate shall not be less than 1 inch high. Identify individual components and modules within the cabinets by engraved laminated phenolic resin nameplates.
- C. Systems: Provide for separate and independent alarm and supervisory systems in the FACP. The alarm initiating zone boards in the FACP shall consist of plug-in cards. Construction requiring removal of field wiring for module removal is not acceptable.
- D. Control Modules: Types and capacities to perform all functions of the fire alarm system. Provide local, visible, and audible signals to notify of any alarm, supervisory, and trouble condition. Provide each type of audible alarm with a distinctly different sound.
- E. Zones: Make provision in the FACP for all alarm and supervisory zones indicated.
- F. Alphanumeric Display and System Controls: Arrange to provide the basic interface between human operator at FACP and addressable system components, including annunciation, supervision, and control. Provide a display with a minimum of 32 characters, arranged to display alarm, supervisory, and component status messages and indicate control commands to be entered into the system for control of smoke detector sensitivity and other parameters.
- G. Voice Alarm: An integrated, UL listed, life safety, and emergency communication system, complying with the requirements of NFPA 72, FACP shall include central voice alarm system components complete with all necessary microphones, pre-amplifiers,

amplifiers, and tone generators. Features shall include:

1. Amplifiers: Comply with UL 1711, "Amplifiers for Fire Protective Signaling Systems."
2. Alarm Channels: Two channels to permit simultaneous transmission of different voice evacuation announcements to specific zones or floors as well as emergency public address announcements to specific areas via the central control microphone. All announcements shall be made over dedicated, supervised communication lines.
3. Status Annunciator: Indicating the status of the various voice alarm speaker zones as well as the status of fire fighter telephone two-way communication zones.
4. Instructions: Provide a typeset, printed, or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a location observable from the FACP. Describe steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions: normal, alarm, and trouble. Obtain approval for instructions before mounting.

2.9 GRAPHIC ANNUNCIATOR

- A. Annunciator Panel: Indicating the building floor plan with a "you are here" designation. Provide an LED indicating light located on the floor plan in each zone. Mark zone boundaries on the annunciator floor plan. Provide lights that indicate the floor on which a signal was actuated if this differs from the zone. Engrave zone and floor designations on the face of the annunciator.
- B. Indicating Lights: Individual LED indicating lights for each type of alarm and supervisory device. Provide an LED to indicate trouble. The actuation of any alarm or supervisory signal shall cause the illumination of a zone light, floor light, and device light. System trouble shall cause the illumination of all of these lights and also the trouble light. In addition to these LED indicators, provide normal power and emergency power indicating lights. Provide a toggle switch or push-button LED test switch. The test switch shall not require key operation.
- C. Material and Legend: Satin finish stainless steel or brushed aluminum for annunciator face plate frame, glass face plate with silk screen text and linework. Provide floor plan boundary lines in the face plate with white lines. Provide zone boundary lines at with red lines. Provide legends for the various LED indicating lights in the annunciator face plate. See details on plans.

2.10 EMERGENCY POWER SUPPLY

- A. General: Components include battery, charger, and an automatic transfer switch.
- B. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate

the complete alarm system in normal or supervisory (nonalarm) mode for a period of 24 hours. Following this period of operation on battery power, the batteries shall have sufficient capacity to operate all components of the system, including all alarm indicating devices in alarm or supervisory mode for a period of 15 minutes.

- C. Automatic Transfer Switch: Transfer the load to the battery without loss of signals or status indications in the event of the failure of primary power.
- D. Battery Charger: Solid-state, fully automatic, variable- charging-rate type. Provide for 150 percent of the connected system load while maintaining the batteries at full charge. In the event batteries are fully discharged, the charger shall recharge them fully within four hours. Charger output shall be supervised as part of system power supply supervision.

2.11 WIRE

- A. Line-Voltage and Low-Voltage Circuits: Solid copper conductors with 600-V rated insulation.
- B. Suitable for areas installed and raceways utilized per manufacturer's recommendations.
- C. Fire alarm circuits shall be zoned in accordance with the Drawings and as indicated herein.
- D. Annunciator circuits shall be supervised for open and ground conditions as recommended by the manufacturer.
- E. Minimum wire size on input initiating circuits shall be #16 AWG up to 200 ft., #14 AWG over 200 ft. to 500 ft. and #12 AWG over 500 ft.
- F. Minimum wire size on alarm signaling (and control) circuits shall be #14 AWG up to 500 ft. and #12 AWG over 500 ft.
- G. All other wire size shall be #12 AWG.
- H. All wire shall be solid conductor THWN type.

2.12 TAGS

- A. Tags for Identifying Tested Components: Comply with NFPA 72H.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

- A. Review Drawings for systems designations, systems boundaries, device locations, zone designations, trunk risers, and special features.
- B. Equipment mounting heights shall be in accordance with the state and local Fire Alarm Codes and Handicapped Codes.
- C. Provide interconnecting wire and cable between the various system devices for proper system operation as recommended by the manufacturer's representative.
- D. All wiring and raceway shall be concealed from view in finished areas. Plenum rated listed fire alarm cable may be used for all accessible above ceiling locations; install cable properly supported from J-hooks. For all other locations install all wire and cable in metallic conduit raceways as specified in Section 260110 - Raceways.
- E. Size raceways and associated boxes as required by the National Electrical Code limiting fill to 30 percent unless otherwise indicated or further reduced by manufacturer's representative's recommendations. Terminate all conduits with bushings.

3.2 COORDINATION

- A. Division 28, together with equipment suppliers and other Divisions, shall coordinate the required number and location of all fire sprinkler tamper and flow switches with the approved contractor design-build fire sprinkler system shop drawings and include the cost of same in the bid.
- B. Division 28, together with equipment suppliers and other Divisions, shall coordinate the number and location of all duct smoke detectors, smoke dampers, and combination fire-smoke dampers as required by the contract documents (both those indicated on floor plans, by drawing notes, by specification, or otherwise) and include the cost of same in the bid.
- C. Division 28, together with equipment suppliers and other Divisions, shall coordinate the number and location of all required control modules and interconnections to the fire alarm system as required by code to properly connect, supervise, monitor, detect, annunciate, and provide output control for those systems required by other specification sections and drawing requirements per applicable code. Provide all programming and other necessary work for full and proper operation as per contract requirements and code.
 - 1. Provide control modules for all magnetic door hold opens.
 - 2. Provide control modules for all magnetic door locks.
 - 3. Provide control modules for mechanical smoke and combination fire/smoke dampers.
 - 4. Provide control modules for other locations required by code.

- D. Recommend to Owner and request approval of nameplate inscriptions, zone designations, and system designations on system annunciators and central control equipment prior to shop drawing submittals.
- E. Division 28, together with equipment suppliers and other Divisions, shall coordinate their equipment operational voltages and controls for proper system operation. Division 28 shall provide any necessary auxiliary equipment for system interfaces. The auxiliary equipment shall provide for, but not be limited to:
 - 1. Remote central station interface.
 - 2. Proper E/P switch smoke damper controls, zoning, and control power.
- F. All information for the system wiring shall be supplied by the manufacturer. The sizes of the different wires shall be those specified by the manufacturer. Building wire shall be in accordance with Section 260120 and NEC articles 760, 775 and 800.
- G. Size annunciators for 25 percent additional space for future expansion. Submit individual calculations with shop drawings.

3.3 INSTALLATION

- A. Install device boxes of size and type recommended by manufacturer's representative to suit device and location shown on Drawings. Paint cover of boxes for fire system red. Install central control and terminal cabinets at five feet above floor to center, unless otherwise noted, supported independently from stud partitions.
- B. Utilize existing dedicated fused disconnect switch on power line to FACP complete with nameplate "FIRE ALARM SYSTEM".
- C. Place batteries in the fire alarm control unit or similar type enclosure located next to the control unit. Batteries which vent explosive hydrogen gas (gelled-electrolyte, lead-calcium, lead-antimony, and nicked-cadmium) shall not be placed in the same enclosure as the fire alarm control panel. Such batteries shall be placed in an area with suitable ventilation. It shall be the responsibility of the fire alarm supplier to advise the engineer and contractor at bid time of any special ventilation requirements not provided as part of the fire alarm contract.
- D. Locate system end of line diodes or resistors so that they are readily accessible above accessible ceiling spaces at the furthest downstream device or in FATC cabinets in equipment rooms. Identify associated circuit by nameplate.
- E. Install raceway systems and ground per applicable codes.
- F. Furnish and install components required by performance requirements listed in the contract documents.

- G. Install additional fire alarm initiation and notification devices specified in paragraph 1.9, N as directed by the engineer. Make additional devices completely operational as required.
- H. All detectors shall be located at the highest point on the ceiling except as specifically noted.
- I. Connect all devices mounted on suspended ceilings to securely mounted junction boxes with flexible metallic conduit which shall be long enough to move the device five (5) feet in any direction.
- J. Mount detector bases on ceiling boxes so that the indicator lamps are visible from the floor below (lined up in corridor applications) or from the nearest equipment aisle or from the doorway entering the room. Provide remote indicator and test stations for all ceiling concealed detectors, detectors mounted above eight feet, and for units where the indicator lamp is not clearly visible from the floor.
- K. Install wire and cable making no splices. If splices must be made, provide terminal block connections. Properly color code and provide minimum twelve inch pigtailed at boxes for equipment. Tag at each end throughout system.
- L. Make all connections to screw type terminals, connectors or terminal boards. Use matching plugs or receptacles where required. Spliced cables or soldered connectors are prohibited. Identify and label all wire terminals and blocks.
- M. Label central control equipment and terminal cabinet components by functional description.
- N. Provide high range speakers for all mechanical spaces and assembly spaces. Provide low range speakers for all other locations. Provide high range speakers (in lieu of low range speakers) for those locations deemed to have inadequate sound pressure or intelligibility during field testing; include all costs for field adjustments.
- O. Provide protective covers over all fire alarm devices in Gymnasiums, Multi-purpose Rooms, and other spaces normally subject to damage from balls. Protective covers shall allow normal device functionality.

3.4 GROUNDING

- A. Ground equipment and conductor and cable shields. For audio circuits, minimize to the greatest extent possible ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.5 FIELD QUALITY CONTROL

- A. **Manufacturer's Field Services:** Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
- B. **Pretesting:** Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
- C. **Report of Pretesting:** After pretesting is complete, provide a letter certifying the installation is complete and fully operable. The letter shall include the names and titles of the witnesses to the preliminary tests.
- D. **Final Test Notice:** Provide 10 days' minimum notice in writing when the system is ready for final acceptance testing.
- E. **Minimum System Tests:** Test the system in accordance with the procedures outlined in NFPA 72H. Minimum required tests are as follows:
 - 1. Verify the absence of unwanted voltages between circuit conductors and ground.
 - 2. Megger test all conductors other than those intentionally and permanently grounded with electronic components disconnected. Test for resistance to ground. Report readings less than 1- megohm for evaluation.
 - 3. Test all conductors for short circuits utilizing an insulation testing device.
 - 4. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the record drawings.
 - 5. Verify the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.
 - 6. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of the initiating and indicating devices. Proper signal transmission in accordance with class of wiring used shall be observed.
 - 7. Test each initiating and indicating device for alarm operating and proper response at the control unit. Test smoke detectors with actual products of combustion.
 - 8. Test the system for all specified functions in accordance with the manufacturer's operating and maintenance manual. Systematically initiate specified functional performance items at each station including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications. Observe all voice audio for routing, clarity, quality, freedom

from noise and distortion, and proper volume level.

9. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the period and in the manner specified.
- F. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Division 28's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
- G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests.
- H. Tag all equipment and stations and other components at which tests have been satisfactorily completed. Place tags upon completion of tests.

3.6 RECORD DRAWINGS

- A. Supply two complete sets of record drawings showing in diagrammatic form all interconnection wiring, zones, etc. with terminal designations for all devices.

3.7 COMMISSIONING

- A. Provide the services of a factory-authorized service representative to demonstrate and train Owner's maintenance personnel as specified below.
- B. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintenance of the system. Provide a minimum of (2) four-hour training sessions.
- C. Schedule training with the Owner at least seven days in advance.
- D. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

END OF SECTION

SECTION 284000 – ACCESS CONTROL AND ALARM SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The supplier shall provide all necessary labor, tools, equipment and materials required to furnish and install a complete and fully operational Galaxy Card Access System. The supplier shall have a minimum of five (5) years experience in the design, installation, and engineering of access control/alarm monitoring systems.
- B. Provide new complete and operational **Galaxy Card Access Control System (no substitutions)**. Provide all material, products, programming and services for a complete and operational system. Contractor shall provide all mounting hardware and door-frame preparation as required.
- C. Provide Viking Video Entry and Door Intercom System E-65-BK-EWP.
- D. Contractor shall provide the services of a manufacturer authorized installer with experience on other Maryland State Police facility security systems.
Provide the services of:
Mobile Communications America (MCA)
Brian Piccolo, Regional Sales Director
410-952-4978 or 410-536-1999 x 107
BrianPiccolo@callmc.com

OR
ABSOLUTE SECURITY GROUP INC
300 Mill St suite a, Salisbury, MD 21801
(410)860-0620
Stephen T. Smith VP
steve@absolutesecuritygroup.com

OR
Approved, Galaxy & Digital Watchdog Certified and qualified equal

1.2 CONTRACT REQUIREMENTS

- A. The supplier shall provide and install a new Galaxy Access Control System in the Building, in accordance with the Plans and Specifications. The System shall be modular in design with the ability to expand or migrate to a larger multi-user, multi-tasking system without replacing existing intelligent application nodes, card readers, cards, input devices or output devices. The

system shall be capable of being upgraded without losing the existing database.

- B. Provide and install Galaxy 635 series controllers, Galaxy Dual Reader Interface Boards, Alarm-Saf AS/PS5BFS-12-UL 12 VDC power supplies with battery backup, and Galaxy Ethernet protocol converters as required.
- C. Provide and install Galaxy Ethernet protocol converters for connection to the computer workstation.
- D. The Contractor shall be responsible for extending the network wiring to the computer workstations.
- E. Provide and install all peripheral devices shown, and system programming to form a fully functional operating system.
- F. Submit Manufacturer's data on Card Access System equipment including, but not limited to, manufacturer's product data sheets for all system components and their quantities. Also include standard of typical riser and wiring diagrams, as well as floor plans showing device locations and the wiring thereof.

1.3 SYSTEM OPERATION

- A. Valid Access: Requires presentation of card-to-card reader so that valid card holders, who are authorized for entry at a specific door at a specific time shall be granted access.
- B. Valid Exit: Request to exit pushbutton or motion detector shall bypass door alarm and unlock door to allow egress.
- C. Alarm Conditions:
 - 1. Alarm conditions will occur in the following circumstances:
 - a. Door is held or propped open.
 - b. Door is forced open, without using proper access card.
 - c. Invalid card holder attempts access.
 - 2. All system events shall be recorded in system history buffer.
 - 3. Alarm conditions shall activate the building general partition of the intrusion detection system. Provide interface with Digital Alarm Communicator Transmitter for off-site monitoring.

1.4 WARRANTY

- A. Special Warranty

1. Proximity Access Readers: Proximity readers shall provide a lifetime warranty against workmanship and defects.
2. System Components: Two (2) years from date of Substantial Completion.
3. Labor: Two (2) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ACCESS CONTROL SYSTEM COMPONENTS

- A. The following equipment shall be approved for use on this project. The equipment shall be provided by the Manufacturer's "Factory Authorized Representative". Special systems suppliers or representatives that are not authorized by the Manufacturer to represent their product shall not be allowed to provide this equipment. No exceptions.

1. Controller

Galaxy Control Systems 635 series Controller (Large Panel) with CPU, 8 DRMs & Power Supply, shall serve as the predominant access control engine. The Controller shall provide power, performance, and flexibility for the most demanding applications. Multiple combinations of Alarm Input Control Modules, Output Control Modules, and Card Reader Interface Modules shall be configured.

The Controller shall communicate upstream at 115.2 Kbps via RS-232, RS-485 multi-dropped configurations, modem dial-up communications, or Ethernet TCP/IP Networks. The CONTROLLER shall store 350,000 cardholders. The CONTROLLER shall provide four downstream 2-wire RS-485 channels or two 4-wires-RS485 channels. In either configuration, the CONTROLLER shall allow connection of up to 64 readers or 32 devices on a single Intelligent System Controller.

Required Features and Functionality:

- * Host Communications – 115.2 Kbps direct wire (RS-232/485), Ethernet TCP/IP or Dial-up Communications.
- * 12VAC or 12VDC input power.
- * Supports up to 8 different card formats and 8 asset formats.
- * Issue Code support for both Wiegand and Magnetic formats.
- * Enhanced anti-passback capabilities.
- * Flash memory for real time program updates.
- * Lithium battery back-up.
- * Holidays with grouping.

- * Time zones with 6 time intervals.
- * 1 MB onboard memory expandable to 8 MB (350,000 cardholders – 1 million events).
- * Up to 64 readers or 32 downstream devices.
- * Alarm masking.
- * Individual shunt (ADA required).
- * Up to 9 digit pin codes.
- * Downstream Serial RS-232 device support.

2. Dual Reader Interface Module
Galaxy Control Systems

Device shall accommodate two (2) access control card readers, keypad, or reader with keypad that uses standard data1/data0 and clock/data Wiegand communications supported. Lock/unlock and facility code, off-line access modes shall be supported on reader connected. Each SRI shall support up to 8 different card formats as well as issue codes for both magnetic and Wiegand card formats.

The SRI shall provide a vital link between the CONTROLLER and the card reader attached to the interface. As many as 32 SRI modules shall be multi-droppable using RS-485 2-wire communication up to 16,000 feet (4,000 per port) away from the CONTROLLER. Each SRI module shall be individually addressed for increased reporting capabilities with Access Control software applications. The SRI shall include two (2) programmable inputs that support normally open, normally closed, supervised, and non-supervised circuits and two (2) output relays that support fail-safe or fail-secure operation.

Required Features and Functionality:

- * VDC power supply.
- * Multiple Wiegand Communications (Clock/Data or Dat1/Data0).
- * Two (2) Form-C relay outputs (5A and 1A relays).
- * Two (2) programmable inputs (supervised or non-supervised).
- * Up to eight (8) different card formats.
- * Issue Code support for magnetic and Wiegand formats.
- * Door contact supervision (open/closed).
- * REX push-button monitor.
- * Strike control output.
- * Bi-color status LED support.
- * Beeper control.
- * Plastic mounting channel.

3. Card Reader: Card Reader shall be proximity type, multiformat (125 KHz and 13.56 MHz) Weigand manufactured by HID.
 - a. Provide combination prox card reader and keypad for selected doors. Provide HID 40KNKS-00-000000-1453 Reader with Keypad, Signo 40K
4. Lock Power Supply(ies): Lock power supply shall be manufactured by Alarm-Saf, Model AS/PS5-BFS-12-UL with battery standby. Coordinate voltage requirements with door hardware provided by Architectural Hardware Contractor. Provide quantity as required.
5. Door Contact: Magnetic door contacts shall be concealed mount, as manufactured by Sentrol, Model 1076-W. Where surface mount is required, provide Sentrol Model 2507A. Provide and install one (1) at each card access door.
6. Electric Door Strike – 12 VDC Operation: Electric door strikes shall be provided and installed by the door hardware contractor and wired by the electrical contractor. This strike shall be 12VDC, fail-secure and selected to match door. All strikes shall be wired by the electrical contractor.
7. Access Control Hardware: Refer to and coordinate with architectural hardware schedule/Contractor to provide a complete operating system.

B. SOFTWARE and LICENSES

1. System Communication: System shall provide an interface (Communication Interface Module or CIM) to issue all database changes to the Reader Controllers.
 - a. Provide licensing for each card reader. Provide a Reader Support for 5 years for each reader.
2. Work Station : Provide 2 workstation licenses (System Galaxy Client)
3. Web Service : Provide 1 web based client service license
4. Provide integration with video surveillance security system

2.2 VIDEO ENTRY AND DOOR INTERCOM SYSTEM COMPONENTS

- A. The following equipment shall be approved for use on this project. The equipment shall be provided by the Manufacturer's "Factory Authorized Representative". Special systems suppliers or representatives that are not

authorized by the Manufacturer to represent their product shall not be allowed to provide this equipment. No exceptions.

- B. Provide Viking Video Entry and Door Intercom System E-65-BK-EWP.
 - 1 . Provide one at Vestibule 100

2.3 INTRUSION ALARM SYSTEM

- A. Provide a complete Intrusion alarm system:
 - a. Bosch B9512G-265 Control Panel,
 - b. Altronix PD16W-474 Power Dist Mod,
 - c. Bosch BD1640-265 Plug-in Transformer,
 - d. Bosch B520-265 Aux Power Supply,
 - e. Associated transformers and kits
 - f. Input Modules – Bosch B208-265
- B. Provide Keypad – Bosch D1255-265
- C. Provide Door Alarm Contacts – GRI or approved equal

PART 3 - EXECUTION

3.1 INSTALLATION

- A. System equipment and panels shall be mounted with sufficient clearance for observation and testing. All junction boxes must be clearly marked for easy identification. All wiring shall be in electrical raceways inside walls and partitions, above non-accessible ceilings or through rooms and areas without ceilings. All electrical raceways, mounting boxes, junction boxes and panels shall be securely hung and fastened with appropriate fittings to insure positive grounding throughout the entire system.
- B. System cable shall meet the requirements for a plenum ceiling. It shall be installed above suspended ceiling at the roof deck level in a neat and workmanlike manner using bridle rings.
- C. Wiring splices are to be avoided to the extent possible, and if needed, they must be made only in junction boxes. All conductors in raceways containing more than one wire shall be labeled on each end with "E-Z Markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be number-coded.

- D. All wiring shall be checked and tested by the Contractor to insure that there are no grounds, opens, or shorts before power is applied to the system.
- E. Final connections to the control equipment shall be made by the representative of the Manufacturer and connections to the remote devices shall be made by the Contractor.
- F. Customization of the control equipment to meet the requirements of these specifications shall be as authorized by the Manufacturer and shall be included herein, one time, at the time of final acceptance and no customization shall void the UL listing.
- G. System shall be installed in accordance with the plans and specifications. All applicable Codes shall be met, with particular attention to the National Electric Code (NFPA 70).

3.2 FINAL TESTS, TRAINING AND WARRANTY

- A. Inspect relays and signals for malfunction, and where necessary adjust units for proper operation to fulfill project requirements.
- B. Final adjustment, equipment start-up and operation and maintenance instructions shall be performed by specially trained personnel in direct employ of Manufacturer's representative.
- C. Complete, accurate, step-by-step testing instructions giving recommended and required testing frequency of all equipment, shall be delivered to the Owner upon completion of the system.
- D. Maintenance instructions shall be complete, easy to read, understandable, and shall provide a complete list of all equipment and components with information as to the address and phone number of both the Manufacturer and local supplier of each item.
- E. Operation and Maintenance instruction period shall be four (4) hours, provided after acceptance of the System by the Owner.
- F. The Contractor shall provide a two-year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner during normal working hours. The warranty period shall begin on the date of acceptance by the Owner/Engineer.

END OF SECTION 284000

SECTION 285200 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the work of this Section.

1.2 SUMMARY

- A. Provide all materials and labor for the installation of a grounding and bonding system for communications infrastructure. This section includes requirements for providing a permanent grounding and bonding infrastructure for communications circuits, raceways, and cable tray.
- B. Related Sections
 - 1. Division 27 Section — "Conduit and Backboxes for Communications Systems"

1.3 REFERENCES

- A. The applicable portions of the following specifications, standards, codes and regulations shall be incorporated by reference into these specifications.
 - 1. General:
 - a. National Electrical Code (NEC)
 - b. National Electrical Safety Code (NESC)
 - c. Occupational Safety and Health Act (OSHA)
 - 2. Communications:
 - a. TIA/EIA - 568: *Commercial Building Telecommunications Cabling Standard*
 - b. TIA/EIA - 569: *Commercial Building Standard for Telecommunication Pathways and Spaces*
 - c. TIA/EIA - 606: *The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings*

- d. TIA/EIA - 607: *Commercial Building Grounding and Bonding Requirements for Telecommunications*
- e. ISO/IEC IS 11801: *Generic Cabling for Customer Premises*
- f. BICSI: *BICSI Telecommunications Cabling Installation Manual*
- g. BICSI: *BICSI Telecommunications Distribution Methods Manual (TDMM)*
- h. BICSI: *BICSI Customer-Owned Outside Plant Design Manual (CO-OSP)*

1.4 DEFINITIONS

- A. "TMGB" shall mean *Telecommunications Main Grounding Busbar*. There is typically one TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.
- B. "TGB" shall mean *Telecommunications Grounding Busbar*. There is typically one TGB per telecommunications room. The TGB is connected both to the TMGB and to building structural steel or other permanent metallic systems.
- C. "TBB" shall mean *Telecommunications Bonding Backbone*. The TBB is a conductor used to connect TMGBs to TGBs.

1.5 SYSTEM DESCRIPTION

- A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete, permanent Grounding and Bonding infrastructure for communications circuits, raceways, and cable trays as hereinafter specified and/or shown on the Contract Documents. The Grounding and Bonding system shall support an ANSI/TIA/EIA and ISO/IEC compliant communications Structured Cabling System (SCS).
- B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant Grounding and Bonding system.

1.6 SUBMITTAL INFORMATION

- A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Provide product data submittals for all products at the same time.

1. Submit a letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. The letter shall also state that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
 2. For those items noted as allowing "or equal," and which are not being provided as specifically named, submit standard manufacturer's cut sheets or other descriptive information, along with a written description detailing the reason for the substitution.
 3. Provide standard manufacturer's cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.
- B. Closeout Submittals: Provide submittal information for review as follows:
1. O&M Manual for Communications - At the completion of the project, submit O&M information from product data submittals (above), updated to reflect any changes during the course of construction, to the Designer in the telecommunications-specific O&M Manual for Communications binder labeled with the project name and description.
 2. Records - Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of drawings, specifications and spreadsheets.
 - a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
 - b. Keep Record Drawings at the job site and make available to the Owner and Designer at any time.
 - c. Keep Record Drawings current throughout the course of construction. ("Current" is defined as not more than one week behind actual construction).
 - d. Show identifiers for major infrastructure components on Record Drawings.

1.7 SEQUENCING

1.8 CONTRACTOR WARRANTY:

- A. Provide a Contractor-endorsed two-year service warranty against defects in materials and workmanship.
 - 1. Provide labor attributable to the fulfillment of this warranty at no cost to the Owner.
 - 2. The Contractor Warranty period shall commence upon Owner acceptance of the work.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials shall consist of busbars, supports, bonding conductors and other incidentals and accessories as required.

2.2 MATERIALS

- A. Grounding/Bonding:
 - 1. Telecommunications Main Grounding Bus Bar (TMGB):
 - a. Large (20" x 4" x 1/4"), Pre-drilled: CPI 10622-020, or equal
 - b. Small (10" x 4" x 1/4"), Pre-drilled: CPI 10622-010, or equal
 - 2. Telecommunications Grounding Bus Bar (TGB):
 - a. Large (20" x 4" x 1/4"), Pre-drilled: CPI 10622-020, or equal
 - b. Small (10" x 4" x 1/4"), Pre-drilled: CPI 10622-010, or equal
 - 3. Telecommunications Bonding Backbone: #6 AWG insulated (green in color) copper conductor.
 - 4. Grounding Conductor: #6 AWG insulated (green in color) copper conductor.
- B. Firestopping Material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions.

- C. Labels: As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
 - 1. Hand-carried label maker:
 - a. Brady: ID Pro Plus (or approved equal).
 - 2. Labels:
 - a. Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.
- B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.
- C. All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.
- D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.
- E. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.
- F. Install the grounding and bonding system in a manner ensuring that communications circuits, when installed, are able to fully comply with

the ANSI/TIA/EIA and other references listed in Part 1 — References, above.

- G. Remove surplus material and debris from the job site and dispose of legally.

3.2 INSTALLATION

- A. The grounding and bonding infrastructure system shall not make use of the building plumbing system, unless required to do so by the NEC.

- 1. Coordinate the installation of the grounding and bonding system with the electrical power distribution system grounding infrastructure.

- B. Ground/Bonding:

- 1. TMGB: Provide a minimum of one TMGB per telecommunications entrance room for each building and as shown on the Contract Documents. Install TMGB(s) and directly bond TMGB(s) to electrical service ground and to associated TBB(s). Group protector, busbar bonding, and approved building grounding conductors toward one end of the TMGB and leave space for equipment grounding conductors on the other end.

- 2. TGB: Provide a minimum of one TGB per telecommunications room for each building and as shown on the Contract Documents and as required by the standards, references and codes listed in PART 1 -- REFERENCES above. Directly bond each TGB to its associated TBB and to the nearest building structural steel or other permanent metallic system. Group protector, busbar bonding, and approved building grounding conductors toward one end and leave space for equipment grounding conductors on the opposite end.

- 3. TBB(s) and Grounding Conductors: Provide TBB(s) and grounding conductors as shown on the Contract Documents and as required to bond all non-current carrying metal telecommunications equipment and materials to the nearest TGB. Use TBB(s) to connect the TMGB to each TGB. Route along the shortest and straightest path possible with minimal bends. Bends shall be sweeping. Insulate TBB(s) and conductors from their support. TBB(s) and grounding conductors shall be continuous (without splices).

- a. Ensure that bonding breaks through paint to bare metallic surface of all painted metallic hardware.

- C. Firestopping

1. Only employees trained/certified by the firestopping manufacturer shall apply firestopping materials.
 2. Maintain the fire rating of all penetrated fire barriers. Fire stop and seal all penetrations made during construction.
 - a. Provide firestopping material for through and membrane penetrations of fire-rated barriers.
 - b. Install firestops in strict accordance with manufacturer's detailed installation procedures.
 - c. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in PART 1 – REFERENCES. Apply of sealing material in a manner acceptable to the local fire and building authorities.
 - d. For demolition work, apply firestopping to open penetrations in fire rated barriers where cable is removed. Apply firestopping regardless of whether or not the penetrations are used for new cable or left empty after construction is complete.
 - e. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/re-enterable.
- D. Labels:
1. Label TMGB(s) with "TMGB"
 2. Label TGB(s) with "TGB".
 3. Label TBB(s) and bonding conductors "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

END OF SECTION 285200

SECTION 285800 - CONDUIT AND BACKBOXES FOR ELECTRONIC SAFETY AND SECURITY SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Provide all materials and labor for the installation of a pathway system for inside plant communications circuits. This section includes requirements for horizontal and building backbone raceways, fittings, and boxes specific to communications circuits (cabling) for voice and data.
- B. Related Sections:
 - 1. Division 27 Section — "Grounding and Bonding for Communications Systems"

1.3 REFERENCES

- A. Incorporate by reference the applicable portions of the following specifications, standards, codes into this specification section.
 - 1. General:
 - a. National Electrical Code (NEC)
 - b. National Electrical Safety Code (NESC)
 - c. Occupational Safety and Health Act (OSHA)
 - 2. Communications:
 - a. ANSI/TIA/EIA - 568: *Commercial Building Telecommunications Cabling Standard*
 - b. ANSI/TIA/EIA - 569: *Commercial Building Standard for Telecommunication Pathways and Spaces*
 - c. ANSI/TIA/EIA - 606: *The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings*

- d. ANSI/TIA/EIA - 607: *Commercial Building Grounding and Bonding Requirements for Telecommunications*
- e. ISO/IEC IS 11801: *Generic Cabling for Customer Premises*
- f. BICSI: *BICSI Telecommunications Cabling Installation Manual*
- g. BICSI: *BICSI Telecommunications Distribution Methods Manual (TDMM)*

1.4 DEFINITIONS

- A. "EMT" shall mean Electrical Metallic Tubing.
- B. "RMC" shall mean Rigid Metal Conduit.
- C. "SMR" shall mean Surface Metal Raceway.
- D. "Raceway" shall mean any enclosed channel for routing wire, cable or busbars.
- E. "TMGB" shall mean *Telecommunications Main Grounding Busbar*. There is typically one TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.
- F. "TGB" shall mean *Telecommunications Grounding Busbar*. There is typically one TGB per telecommunications room. The TGB is connected both to the TMGB and to building structural steel or other permanent metallic systems.
- G. "TBB" shall mean *Telecommunications Bonding Backbone*. The TBB is a conductor used to connect TMGBs to the TGBs.
- H. "Pullbox" shall mean a metallic box with a removable cover, used to facilitate pulling cable through conduit runs longer than 100' or in which there are more than 180 degrees of bends.
- I. "Junction box" shall mean a pullbox wherein a feeder conduit transitions to multiple distribution conduits.

1.5 SYSTEM DESCRIPTION

- A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete Raceway system as hereinafter specified and/or shown on the Contract Documents. The Raceway system shall support an ANSI/TIA/EIA and ISO/IEC compliant communications Structured Cabling

System (SCS) as specified in 2715 00 - Inside Plant Communications Systems

- B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the Contract Documents but which are necessary to make a complete working Raceway system.

1.6 SUBMITTALS

- A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Provide product data submittals for all products at the same time.

1. Submit a letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. The letter shall also state that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
2. For those items noted as allowing "or equal," and which are not being provided as specifically named, submit standard manufacturer's cut sheets or other descriptive information, along with a written description detailing the reason for the substitution.
3. Provide standard manufacturer's cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.

- B. Closeout Submittals: Provide submittal information for review as follows:

1. O&M Manual for Communications - At the completion of the project, submit all O&M information from product data submittals (above), updated to reflect any changes during the course of construction, to the College in the telecommunications-specific O&M Manual for Communications binder labeled with the project name and description.
2. Records - Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of drawings, specifications and spreadsheets, including maintenance hole/handhole butterfly drawings.

- a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
- b. Keep Record Drawings at the job site and make available to the Owner and Designer at any time.
- c. Keep Record Drawings current throughout the course of construction. ("Current" is defined as not more than one week behind actual construction).
- d. Show identifiers for major infrastructure components on Record Drawings.

1.7 CONTRACTOR WARRANTY:

- A. Provide a Contractor-endorsed one-year service warranty against defects in materials and workmanship.
 1. Provide labor attributable to the fulfillment of this warranty at no cost to the Owner.
 2. The Contractor Warranty period shall commence upon Owner acceptance of the work.

1.8 QUALITY ASSURANCE

- A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.
 1. The Terms "Listed" and "Labeled": As defined in NEC, Article 100.
 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. Comply with NECA's "Standard of Installation."
- C. Comply with NEC.

1.9 COORDINATION

- A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials shall consist of conduit, surface metal raceway, outlet boxes, fittings, enclosures, pull boxes, and other raceway incidentals and accessories as required for inside plant communications circuits.

2.2 MATERIALS

- A. Conduit:
 - 1. EMT. 1" minimum conduit size. Flexible metal conduit (FMC) is not acceptable.
 - a. Conduit: Galvanized steel tubing meeting ANSI C80.3.
 - b. Couplings: Steel, cast iron, or malleable iron compression type employing a split, corrugated ring and tightening nut, with integral bushings and locknuts. Indent-type and setscrew-type couplings are not permitted.
 - 2. RMC. 1" minimum conduit size.
 - a. Conduit: Hot dipped galvanized steel with threaded ends meeting ANSI C80.1.
 - b. Couplings: Unsplit, NPT threaded steel cylinders with galvanizing equal to the conduit.
 - c. Nipples: Same as conduit, factory-made up to 8 inches in diameter, no running threads.
- B. Sleeves: EMT conduit, with insulated throat bushings for each end
- C. Surface Raceway: Wiremold V2400 series or equivalent – Two piece, steel, single channel surface raceway.
- D. Outlet boxes: Minimum 4"x4" size, 2 1/8" minimum depth, with extension rings (if needed) and single gang covers (i.e.; mud rings), unless otherwise noted on the Contract Documents. Combined interior depth of outlet box, extension ring and cover shall be a minimum 2-1/2". Stamped steel, deep drawn one piece (without welds or tab connections), galvanized, with knockouts for 1" trade size conduit or connector entrance, meeting NEMA OS 1.
 - 1. Acceptable manufacturers:
 - a. Appleton, Raco, Steel City, or equal

2. Wiremold Extra Deep Switch and Receptacle Box: V5744-2 (two gang), or equal
 - E. Junction Boxes and Pull Boxes: Stamped steel, deep drawn one piece (without welds or tab connections), galvanized, with knockouts for conduit or connector entrance. Boxes 6"x6"x4" or larger may be code gauge fabricated steel continuously welded at seams and painted after fabrication.
 1. Dry locations: meeting NEMA OS 1.
 2. Wet locations: NEMA OS 3R.
 - F. Miscellaneous Fittings:
 1. Locknuts and conduit bushings: Malleable iron
 - a. Appleton, Crouse Hinds, OZ Gedney, or equal
 2. Through wall seals and floor seals shall be:
 - a. OZ Gedney FS and WS series, or equal.
 - G. Pull Strings: Plastic or nylon with a minimum test rating of 200 lb.
- 2.3 FIRESTOPPING
- A. Material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions.
- 2.4 LABELING AND ADMINISTRATION
- A. Labels: As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, typed, and created by a hand-carried label maker or an approved equivalent software-based label making system. Handwritten labels are not acceptable.
 1. Hand-carried label maker:
 - a. Brady: ID Pro Plus (or approved equal).
 2. Labels:
 - a. Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal).

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.
- B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.
- C. All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.
- D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.
- E. Install the raceway system in a manner ensuring that communications circuits, when installed, are able to fully comply with the ANSI/TIA/EIA and other references listed in Part 1 — References, above.
- F. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.
- G. Remove surplus material and debris from the job site and dispose of legally.

3.2 EXAMINATION

- A. Examine surfaces and spaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions. Provide a raceway for each location indicated. Do not gang raceway into wireways,

pullboxes, junction boxes, etc., without specific approval from the Designer.

B. Conduit:

1. Install EMT unless other conduit is shown on the Contract Documents or is required by Code.
2. Install conduit as a complete, continuous system without wires, mechanically secured and electrically connected to metal boxes, fittings and equipment. Blank-off unused openings using factory-made knockout seals.
3. Run conduit in the most direct route possible, parallel to building lines. Do not route conduit through areas in which flammable material may be stored.
4. Keep conduit at least 6 inches away from parallel runs of flues and steam or hot-water pipes or other heat sources operating at temperatures above one-hundred degrees Fahrenheit. Install horizontal conduit runs above water piping.
5. Keep conduit away from sources of electromagnetic interference as follows:
 - a. 5 inches from fluorescent lighting
 - b. 12 inches from conduit and cables used for electrical power distribution
 - c. 48 inches from motors or transformers
6. Do not exceed 90 meters total length for a given conduit run to be used for distribution cabling (from outlet box to telecommunications room), including intermediate conduits and junction boxes.
7. Install conduit exposed, except in finished areas or unless shown otherwise on the drawings. Do not install conduit below grade/slab unless specifically shown on the Contract Documents as being installed below grade/slab.
8. Install exposed conduit in lines parallel or perpendicular to building lines or structural members except where the structure is not level. Follow the surface contours as much as practical. Do not install crossovers or offsets that can be avoided by installing the conduit in a different sequence or a uniform line.

- a. Run parallel or banked conduits together, on common supports where practical.
 - b. Make bends in parallel or banked runs from same centerline to make bends parallel.
9. Conduits concealed above ceilings, furred spaces, etc., which are normally inaccessible may be run at angles not parallel to the building lines.
 10. Wherever practical, route conduit with adjacent ductwork or piping and support on common racks. Base required strength of racks, hangers, and anchors on combined weights of conduit and piping.
 11. Where conduits cross building expansion joints, use suitable sliding or offsetting expansion fittings. Unless specifically approved for bonding, use a suitable bonding jumper.
 12. Support conduits as specified in Section "Basic Electrical Materials and Methods."
 - a. Provide anchors, hangers, supports, clamps, etc. to support the conduits from the structures in or on which they are installed. Do not space supports farther apart than five feet.
 - b. Provide sufficient clearance to allow conduit to be added to racks, hangers, etc. in the future.
 - c. Support conduit within three feet of each outlet box, junction box, gutter, panel, fitting, etc.
 13. Ream conduits to eliminate sharp edges and terminate with metallic insulated grounded throat bushings. Seal each conduit after installation (until cable is installed) with a removable mechanical-type seal to keep conduits clean, dry and prevent foreign matter from entering conduits.
 14. Install a pull string in each conduit.
 15. For conduits entering through the floor of a telecommunications room, terminate conduits 6" above the finished floor.
 16. Do not install communications conduits in wet, hazardous or corrosive locations.

17. Where conduit is shown embedded in masonry, embed conduit in the hollow core of the masonry. Horizontal runs in the joint between masonry units are not permitted.
18. Where conduit is shown embedded in concrete, embed conduit a minimum of two inches from the exterior of the concrete. Do not place conduit in concrete less than 4 inches thick.
 - a. One inch trade size conduit shall be used. Conduits sized smaller than one inch trade size conduit are not permitted embedded in concrete without approval from the College.
 - b. Run conduit parallel to main reinforcement.
 - c. Conduit crossovers in concrete are not permitted.
19. Where conduit exits from grade or concrete, provide a rigid steel elbow and adapter.
20. Where conduit enters a space through the floor and terminates in that space, terminate the conduit at 6" above the finished floor.
21. Where conduits terminate at a cable tray, the conduits shall be consistently terminated no more than 8" from the cable tray, and have a visually uniform appearance.
22. Where several circuits follow a common route, stagger pullboxes or fittings.
23. Where several circuits are shown grouped in one box, individually fireproof each conduit.
24. Bend and offset metal conduit with standard factory sweeps or conduit fittings. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
 - a. Conduit sweeps:
 - 1) Sweeps shall not exceed 90 degrees.
 - 2) Do not exceed 180 degrees for the sum total of conduit sweeps for a section of conduit (between conduit termination points).
 - 3) Sweep radius shall be at least 10 times the internal diameter of the conduit.
 - 4) 90-degree condulets (LB's) and electrical elbows are not acceptable.

- b. Factory-manufactured sweeps are required for bends in conduit larger than 1-1/4" trade size.
 - c. For bends in 1 1/4" trade size conduit and larger, field-manufactured bends (using a hydraulic bender with a 1 1/4" boot) are permitted only when factory-manufactured sweeps are not suitable for the conditions. In all other cases, factory-manufactured sweeps are required. "Hickey-bender" use is prohibited.
25. Connect conduit to hubless enclosures, cabinets and boxes with double locknuts and with insulating type bushings. Use grounding type bushings where connecting to concentric or eccentric knockouts. Make conduit connections to enclosures at the nearest practicable point of entry to the enclosure area where the devices are located to which the circuits contained in the conduit will connect.
26. Penetrations for raceways:
- a. Do not bore holes in floor and ceiling joists outside center third of member depth or within two feet of bearing points. Holes shall be 1-1/4" diameter maximum.
 - b. Penetrate finished walls and finished surfaces with a PVC or sheet metal sleeve with an interior diameter (ID) at least 1/4" greater than the outer diameter (OD) of the conduit, set flush with walls, pack with fiberglass, seal with silicone sealant.
 - c. Penetrate poured-in-place walls and free slabs with a cast iron sleeve (or Schedule 40 PVC black pipe sleeve for above-grade only) with retaining ring or washer. Set sleeves flush with forms or edges of slab. Pack around conduit with fiberglass and seal with silicone sealant.
27. Raceway terminations and connections:
- a. Join conduits with fittings designed and approved for the purpose and make joints tight. Do not use set indent-type or screw-type couplings.
 - b. Make threaded connections waterproof and rustproof by applying a watertight, conductive thread compound. Clean threads of cutting oil before applying thread compound.
 - c. Make conduit terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.

- d. Cut ends of conduit square using a hand saw, power saw or pipe cutter. Ream cut ends to remove burrs and sharp ends. Where conduit threads are cut in the field, cut threads to have same effective length, same thread dimensions and same taper as specified for factory-cut threads.
 - e. Provide double locknuts and insulating bushings at conduit connections to boxes and cabinets. Align raceways to enter squarely and install locknuts with dished part against the box. Use grounding type bushings where connecting to concentric or eccentric knockouts.
 - f. Where conduits are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
28. Install conduit sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed conduits, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
- a. Where conduits pass from warm to cold locations, such as the boundaries of air conditioned or refrigerated spaces and where conduits enter or exit buildings from outdoor areas, including underground ducts or conduit runs.
 - b. Where otherwise required by the NEC.
29. Conduit shall be clean and dry.

C. Sleeves:

- 1. Provide sleeves where required, sized as noted on the Contract Documents. Where not noted, sleeve sizing shall be determined by the type and quantity of cable to be routed through the sleeve per TIA/EIA 569A cable capacity standards, plus an additional 20% for future expansion.
- 2. Provide roto-hammering or core drilling where required for installation.
- 3. Seal between sleeve and wall or floor in which the sleeve is installed. Firestop all penetrations to restore wall or floor to pre-penetration fire-rating.

D. Surface Raceway:

1. Provide surface raceway for all surface mounted telecommunications outlet boxes and as shown on the Contract Documents.
2. Surface raceway shall be routed parallel to and perpendicular to surfaces or exposed structural members, and follow surface contours.
3. Surface raceway color shall match as closely as possible the existing wall finish. Do not paint Surface Raceway.
4. Surface raceway systems shall be completely installed, including insulating bushings and inserts as required by manufacturer's installation requirements. Unused openings in the surface raceway shall be closed using manufactured fittings.
5. Surface raceway shall have a minimum two inch radius control at all bend points.
6. Surface raceway shall be securely supported by screws or other anchor-type devices at intervals not exceeding 10 feet and with no less than two supports per straight raceway section. Surface raceway shall be securely supported in accordance with the manufacturer's requirements. Tape and glue are not acceptable support methods.
7. Mechanically and electrically continuous surface raceway shall be bonded and grounded to the Telecommunications Grounding system.

E. Outlet Boxes:

1. Provide outlet boxes and covers as shown on the Contract Documents and as needed. Verify that the appropriate cover type and depth is provided for each type of wall and finish. Provide extension rings as needed.
2. Coordinate box locations with building surfaces and finishes to avoid bridging wainscots, joints, finish changes, etc.
3. Install boxes in dry locations (not wet, corrosive, or hazardous).
4. Attach boxes securely to building structure with a minimum of two fasteners. Provide attachments to withstand a force of one hundred pounds minimum, applied vertically or horizontally.

5. Install boxes at the following heights to the bottom of the box, except where noted otherwise:
 - a. Wall mounted telephones: 48" above finished floor.
 - b. Workstation outlets: 18" above finished floor.
 - c. Place boxes for outlets on cabinets, countertops, shelves, and similar boxes located above countertops two inches above the finished surface or two inches above the back splash. Coordinate and verify size, style, and location with the supplier or installer of these items prior to outlet box installation.
 6. Recessed mounted outlet boxes:
 - a. Recess boxes in the wall, floor, and ceiling surfaces in finished areas. Set boxes plumb, level, square and flush with finished building surfaces within one-sixteenth inch for each condition. Set boxes so that box openings in building surfaces are within one-eighth inch of edge of material cut-out and fill tight to box with building materials. Single gang opening shall extend at least to the finished wall surface and extend not more than 1/8 inch beyond the finished wall surface. Provide backing for boxes using structural material to prevent rotation on studs or joists.
 - b. Install floor boxes level and adjust to finished floor surface.
 7. Surface-mounted outlet boxes:
 - a. For boxes surface-mounted on finished walls, provide Wiremold outlet box or equivalent. Cut box as necessary to accept conduit.
 - b. For boxes surface-mounted on unfinished walls (i.e. electrical rooms, mechanical rooms), provide 4"x4" (minimum) outlet box with single gang cover.
- F. Floor Boxes:
1. Provide floor boxes as shown on the Contract Documents.
 2. Set device boxes plumb, level, square and flush with floor, within 1/16" tolerance for each condition.
 3. For floor boxes with combined power and telecommunications circuits, provide metal dividers to separate power from telecommunications circuits.

G. Junction Boxes:

1. Provide junction boxes as shown on the Contract Documents and as required.
 - a. Where sizing is not shown on the Contract Documents, size junction box length and depth according to the size of the feeder conduit in the following table:

Feeder Conduit Size	Box Length	Box Depth
1"	12"	4"
1-1/4"	12"	4"
1-1/2"	12"	4"
2"	24"	4"
2-1/2"	24"	6"
3	36"	6"
3-1/2"	48"	6"
4"	60"	6"

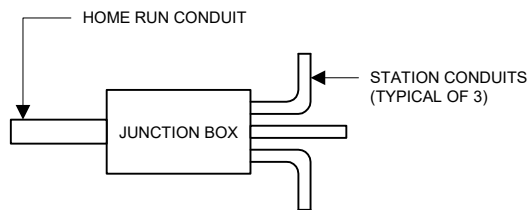
- b. Where sizing is not shown on the Contract Documents, size junction box width according to the following formula:
 - 1) From the table below, select the width associated with the largest conduit on the distribution side of the box. For each additional distribution conduit, add the "Increase Width" value associated with the size of that distribution conduit to the box width for the largest distribution conduit.
 - a) For example, if the distribution side of the junction box has one 1-1/4" distribution conduit and three 1" distribution conduits, the total distribution-side width would be 6"+2"+2"+2"=10".
 - 2) Repeat the above process for the feeder side of the junction box. Junction boxes are typically fed by a single conduit, therefore unless the box has more than one feeder conduit, the "Increase Width" part of the formula is unnecessary.

- a) For example, if the feeder side of the junction box has two 2" feeder conduits the total feeder-side width would be 8"+5"=13".
- 3) The larger of the two width calculations (distribution side vs. feeder side) shall be the width of the junction box to be provided.
 - a) For example, if the distribution-side width were 10" and the feeder-side width were 13", provide a 13" wide junction box.

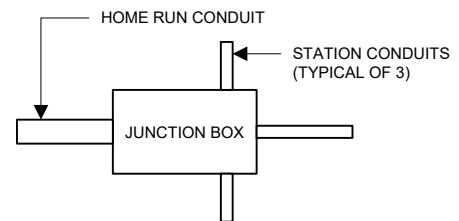
Conduit Size	Box Width	For each additional conduit Increase Width
1"	4"	2"
1-1/4"	6"	3"
1-1/2"	8"	4"
2"	8"	5"
2-1/2"	10"	6"
3"	12"	6"
3-1/2"	12"	6"
4"	15"	8"

- 2. A junction box may not be substituted for a 90-degree bend. 90 degree condulets (LB's) are not acceptable.
- 3. Install junction boxes in a location readily accessible both at time of construction and after building occupation. Do not install junction boxes in inaccessible interstitial building spaces.
- 4. Where junction boxes are to be mounted on ceiling structure above ceiling grid, do not mount higher than 4' above grid.
- 5. Install hinged-cover enclosures and cabinets plumb, and supported at each corner.

6. Install junction boxes so that the access door opens from the side where the cable installer will normally work – typically from the bottom (floor side) of the box.
 - a. Where a junction box is installed in a ceiling space, coordinate with other trades to provide full access to the junction box door and adequate working room for both the installation personnel and for proper looping of cable during installation.
 - b. Provide a lockable access cover (or junction box door if junction box is exposed) in hard lid ceilings.
7. Install junction boxes such that conduits enter and exit at opposite ends of the box as follows:



CORRECT INSTALLATION



INCORRECT INSTALLATION

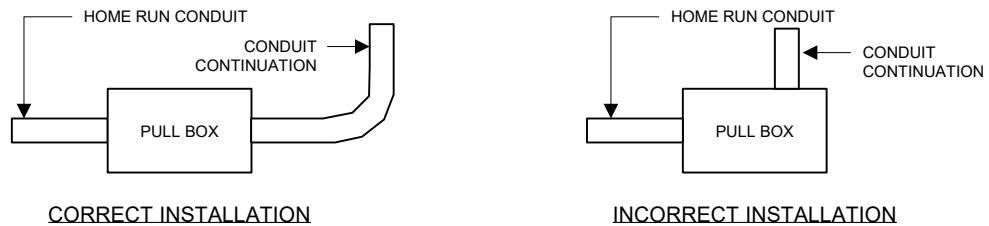
H. Pull Boxes:

1. Provide pull boxes as shown on the Contract Documents and as required.
 - a. Where sizing is not shown on the Contract Documents, size pull boxes as follows:

Size of Largest Conduit	Box Width	Box Length	Box Depth
1"	4"	12"	4"
1-1/4"	6"	12"	4"
1-1/2"	8"	12"	4"
2"	8"	24"	4"
2-1/2"	10"	24"	6"
3"	12"	36"	6"
3-1/2"	12"	48"	6"
4"	15"	60"	6"

- b. Where a pull box is required with conduits 1" trade size or smaller, an outlet box may be used as a pull box. Where outlet boxes are used as pull boxes, the outlet boxes shall be dedicated for use as a pull box and shall not host cable termination hardware.
2. A pull box may not be substituted for a 90-degree bend. 90 degree condulets (LB's) are not acceptable.
3. Install pull boxes in an accessible location, readily accessible both at time of construction and after building occupation. Do not install pull boxes in inaccessible interstitial building space.
4. Where pull boxes are to be mounted on ceiling structure above ceiling grid, do not mount higher than 4' above grid (mount on wall instead).
5. Install hinged-cover enclosures and cabinets plumb, and supported at each corner.
6. Install pull boxes so that the access door opens from the side where the cable installer will normally work (typically from the bottom, or floor side, of the box).
 - a. Where a pull box is installed in a ceiling space, provide full access to the junction box door and adequate working room for both the installation personnel and for proper looping of cable during installation.

- b. Provide a lockable access cover (or pull box door if pull box is exposed) in hard lid ceilings.
7. Install pull boxes such that conduits enter and exit at opposite ends of the box as follows:



I. Firestopping:

1. Only employees trained/certified by the firestopping manufacturer shall apply firestopping materials.
2. Maintain fire rating of penetrated fire-rated walls. Firestop and seal each penetration made during construction.
 - a. Provide firestopping material for through and membrane penetrations of fire-rated barriers.
 - b. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures.
 - c. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in PART 1 – REFERENCES. Apply all sealing material in a manner acceptable to the local fire and building authorities.

J. Grounding/Bonding: Grounding and bonding work shall comply with the Virginia Uniform Statewide Building Code, Uniform Fire Code, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in PART 1 – REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.

1. Bond metallic raceway together and to the nearest TGB (as provided under Division 27 Section — "Grounding and Bonding for Communications Systems"). Ensure that bonding breaks through paint to bare metallic surface of painted metallic hardware.

3.4 LABELS:

- A. Conduits: For any conduit extending beyond the space or room in which it starts, label each such conduit end in a clear manner by designating the location of the other end of the conduit (i.e. room name, telecommunications room name, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.). Indicate conduit length on the label.
 - 1. Where a conduit is intended for future cabling use outside of the Contract, the conduit shall be labeled in a clear manner by designating the location of the other end of the conduit (i.e. room name, telecommunications room name, pull box identifier, etc.) along with a sequential number for each spare conduit terminated into a single room. Indicate conduit length on the label.
 - a. Suggestion: The second spare conduit (whether spare or in use) between Room 100 and telecommunications room 1A might be labeled in the telecommunications room as "Room 100 - #2, __ feet." In Room 100 the same conduit might be labeled "1A - #2, __ feet."
- B. Pull Boxes: Label each pullbox with a unique identifier. Identifiers shall be of the form "RN-Y" where "RN" is the room name of the room closest to (or containing) the pull box, and "Y" is the sequential number of the pull box for each "RN".
 - 1. Example: The second pull box in the vicinity of room "100" would have the label "100-2".
- C. Pull Strings: For any conduit extending beyond the space or room in which it starts, label its pull string in a clear manner by designating the location of the other end of the pull string (i.e. room name, telecommunications room name, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.).
 - 1. Where a pull string is installed in a conduit intended for future cabling use outside of the Contract, the pull string shall be labeled similar to the spare conduit in which it is installed.

3.5 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and in accordance with accepted industry practice, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.6 CLEANING

1. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 285800

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Stripping and stockpiling rock.
6. Removing above- and below-grade site improvements.
7. Disconnecting, capping or sealing, and removing site utilities or abandoning site utilities in place.
8. Temporary erosion and sedimentation control.

- B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

- C. Related Requirements:

1. Section 01500 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

- A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of

subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

- D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 MATERIAL OWNERSHIP

- A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.6 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or video recordings.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.
- B. Topsoil stripping and stockpiling program.
- C. Rock stockpiling program.
- D. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.7 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.

- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises.
- C. Utility Locator Service: Notify Miss Utility for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.
- E. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- F. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
 - 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

- A. Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 EXISTING UTILITIES

- A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
 - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
 - 1. Arrange with utility companies to shut off indicated utilities.
- C. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- E. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots larger than 2 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods or air spade for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.
3. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 STOCKPILING ROCK

A. Remove from construction area naturally formed rocks that measure more than 1 foot across in least dimension. Do not include excavated or crushed rock.

1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

3.8 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

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100% CD Specifications

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for concrete walks and pavements.
6. Subbase course and base course for asphalt paving.
7. Subsurface drainage backfill for walls and trenches.
8. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Requirements:

1. Section 013200 "Construction Progress Documentation" for recording pre-excavation and earth-moving progress.
2. Section 311000 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
3. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
4. Section 329300 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.2 UNIT PRICES

- A. Quantity allowances for earth moving are included in Section 012100 "Allowances."

1.3 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

- B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
 - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, will be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Rock:
 - 1. Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D1586.
- I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other fabricated stationary features constructed above or below the ground surface.
- J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct pre-excavation conference at Project site.
 - 1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
 - a. Personnel and equipment needed to make progress and avoid delays.

- b. Coordination of Work with utility locator service.
- c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
- d. Extent of trenching by hand or with air spade.
- e. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Warning tapes.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Geotextile: 12 by 12 inches.
2. Warning Tape: 12 inches long; of each color.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D2487.
2. Laboratory compaction curve according to ASTM D698.

C. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.7 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

1.8 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

- B. Utility Locator Service: Notify "Miss Utility" for area where Project is located before beginning earth-moving operations.
- C. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 015000 "Temporary Facilities and Controls" and Section 311000 "Site Clearing" are in place.
- D. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.
- E. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Foot traffic.
 - 4. Erection of sheds or structures.
 - 5. Impoundment of water.
 - 6. Excavation or other digging unless otherwise indicated.
 - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- F. Do not direct vehicle or equipment exhaust towards protection zones.
- G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
 - 1. Liquid Limit: 40.
 - 2. Plasticity Index: 20.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.
- I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.
- J. Sand: ASTM C33/C33M; fine aggregate.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 - 1. Survivability:
 - a. Class 2; AASHTO M 288.
 - b. As follows:
 - 1) Grab Tensile Strength: 200 lbf; ASTM D4632.
 - 2) Tear Strength: 80 lbf; ASTM D4533.
 - 3) Puncture Strength: 450 lbf; ASTM D4833.
 - c. Apparent Opening Size: No. 70 sieve, maximum; ASTM D4751.
 - d. Permittivity: 1.1 per second, minimum; ASTM D4491.
 - e. UV Stability: 70 percent after 500 hours' exposure; ASTM D4355.

- B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Survivability:
 - a. Class 2; AASHTO M 288.
 - b. As follows:
 - 1) Grab Tensile Strength: 200 lbf; ASTM D4632.
 - 2) Tear Strength: 75 lbf; ASTM D4533.
 - 3) Puncture Strength: 450 lbf; ASTM D4833.
 - c. Apparent Opening Size: No. 30 sieve, maximum; ASTM D4751.
 - d. Permittivity: 0.05 per second, minimum; ASTM D4491.
 - e. UV Stability: 70 percent after 500 hours' exposure; ASTM D4355.

2.3 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:
1. Red: Electric.
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems.
 5. Green: Sewer systems.
- B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
1. Red: Electric.
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems.
 5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

- A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
- B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
- D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

3.3 EXPLOSIVES

- A. Explosives:
 - 1. Do not use explosives.

3.4 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
 - a. 24 inches outside of concrete forms other than at footings.
 - b. 12 inches outside of concrete forms at footings.
 - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 - e. 6 inches beneath bottom of concrete slabs-on-grade.
 - f. 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
 2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
 3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
 1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
 - 1. Clearance: 12 inches each side of pipe or conduit.
- C. Trench Bottoms:
 - 1. Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
 - a. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- D. Trenches in Tree- and Plant-Protection Zones:
 - 1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - 2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
 - 3. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.8 EXCAVATION FOR ELEVATOR CYLINDER

- A. Drill well hole plumb in elevator pit to accommodate installation of elevator-cylinder assembly. Coordinate with applicable requirements for diameter and tolerances in Section 142400 "Hydraulic Elevators."
- B. Provide well casing as necessary to retain walls of well hole.

3.9 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

- C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 - 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.10 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
 - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.11 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.12 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 - 2. Surveying locations of underground utilities for Record Documents.
 - 3. Testing and inspecting underground utilities.
 - 4. Removing concrete formwork.
 - 5. Removing trash and debris.
 - 6. Removing temporary shoring, bracing, and sheeting.
 - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.13 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
- D. Trenches under Roadways: Provide 4-inch-thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
- E. Backfill voids with satisfactory soil while removing shoring and bracing.
- F. Initial Backfill:
 - 1. Soil Backfill: Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
 - a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- G. Final Backfill:
 - 1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
- H. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.14 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
 - 2. Under walks and pavements, use satisfactory soil material.

3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.15 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.16 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D698:
1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
 3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
 4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.17 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
1. Provide a smooth transition between adjacent existing grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
 - 1. Turf or Unpaved Areas: Plus or minus 1 inch.
 - 2. Walks: Plus or minus 1 inch.
 - 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.18 SUBSURFACE DRAINAGE

- A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
 - 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698.
- B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
 - 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698.

3.19 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
 - 1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 - 2. Place base course material over subbase course under hot-mix asphalt pavement.
 - 3. Shape subbase course and base course to required crown elevations and cross-slope grades.
 - 4. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
 - 5. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.20 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
 1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 2. Place drainage course 6 inches or less in compacted thickness in a single layer.
 3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.21 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- D. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:
 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft or less of paved area or building slab but in no case fewer than three tests.
 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.
 3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.

- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.22 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.23 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.
- B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.
 - 1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt overlay.
3. Cold milling of existing asphalt pavement.
4. Hot-mix asphalt patching.

- B. Related Requirements:

1. Section 312000 "Earth Moving" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
2. Section 321313 "Concrete Paving" for concrete pavement and for separate concrete curbs, gutters, and driveway aprons.
3. Section 321373 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
 - a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
 - b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.4 ACTION SUBMITTALS

- A. Product Data: Include technical data and tested physical and performance properties.

B. Hot-Mix Asphalt Designs:

1. Certification, by authorities having jurisdiction, of approval of each hot-mix asphalt design proposed for the Work.
2. For each hot-mix asphalt design proposed for the Work.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For paving-mix manufacturer and testing agency.
- B. Material Certificates: For each paving material, by a qualified testing agency.
- C. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by the Maryland State Highway Administration.
- B. Testing Agency Qualifications: Qualified in accordance with ASTM D3666 for testing indicated.
- C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of AASHTO and the Maryland State Highway Administration for asphalt paving work.
 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
 1. Tack Coat: Minimum surface temperature of 60 deg F.
 2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. General: Use materials and gradations that have performed satisfactorily in previous installations.
- B. Coarse Aggregate: ASTM D692/D692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
- C. Fine Aggregate: ASTM D1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
 - 1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

2.2 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO M 320 binder designation PG 64-22.
- B. Asphalt Cement: In accordance with Maryland State Highway Administration standards and specifications.
- C. Tack Coat: In accordance with Maryland State Highway Administration standards and specifications.
- D. Water: Potable.

2.3 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.
- B. Joint Sealant: In accordance with Maryland State Highway Administration standards and specifications.

2.4 MIXES

- A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by Maryland State Highway Administration Standards and Specifications; and complying with the following requirements:
 - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 - 2. Base Course: HMA Superpave-12.5mm PG64-22.

3. Surface Course: HMA Superpave-19mm PG64-22..

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protection: Provide protective materials, procedures, and worker training to prevent asphalt materials from spilling, coating, or building up on curbs, driveway aprons, manholes, and other surfaces adjacent to the Work.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

3.3 COLD MILLING

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
 1. Mill to a depth of 2 inches.
 2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
 3. Control rate of milling to prevent tearing of existing asphalt course.
 4. Repair or replace curbs, driveway aprons, manholes, and other construction damaged during cold milling.
 5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
 6. Patch surface depressions deeper than 1 inch after milling, before wearing course is laid.
 7. Keep milled pavement surface free of loose material and dust.
 8. Do not allow milled materials to accumulate on-site.

3.4 PATCHING

- A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseal concrete pieces firmly.
 - 1. Undersealing: Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseal pieces firmly.
 - 2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.
- C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd..
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- D. Placing Single-Course Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.5 REPAIRS

- A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
 - 1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.
- B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.
 - 1. Clean cracks and joints in existing hot-mix asphalt pavement.
 - 2. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.6 SURFACE PREPARATION

- A. Ensure that prepared subgrade has been proof-rolled and is ready to receive paving. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces.

- B. Herbicide Treatment: Apply herbicide in accordance with manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
 - 1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.7 HOT-MIX ASPHALT PLACEMENT

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 - 1. Place hot-mix asphalt base course and binder course in number of lifts and thicknesses indicated.
 - 2. Place hot-mix asphalt surface course in single lift.
 - 3. Spread mix at a minimum temperature of 250 deg F.
 - 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
 - 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
 - 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
 - 2. Complete a section of asphalt base course and binder course before placing asphalt surface course.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.8 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method in accordance with AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.9 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 1. Average Density, Marshall Test Method: 96 percent of reference laboratory density in accordance with ASTM D6927 or AASHTO T 245, but not less than 94 percent or greater than 100 percent.
 2. Average Density, Rice Test Method: 92 percent of reference maximum theoretical density in accordance with ASTM D2041/D2041M, but not less than 90 percent or greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.10 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/2 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Pavement Surface Smoothness: Compact each course to produce surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.
 - 2. Surface Course: 1/8 inch.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined in accordance with ASTM D3549/D3549M.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement in accordance with ASTM D979/D979M or AASHTO T 168.
 - 1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared in accordance with ASTM D2041/D2041M, and compacted in accordance with job-mix specifications.
 - 2. In-place density of compacted pavement will be determined by testing core samples in accordance with ASTM D1188 or ASTM D2726/D2726M.
 - a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than three cores taken.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method in accordance with ASTM D2950/D2950M and coordinated with ASTM D1188 or ASTM D2726/D2726M.
- E. Replace and compact hot-mix asphalt where core tests were taken.

Maryland State Police
Tactical Administration Center
PA-745-210-001
100% CD Specifications

- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes Concrete Paving. Including the Following:
 - 1. Parking lots.
 - 2. Curbs and gutters.
 - 3. Walks.
- B. Related Requirements:
 - 1. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.
 - 2. Section 321723 "Pavement Markings."

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to concrete paving, including but not limited to, the following:
 - a. Concrete mixture design.
 - b. Quality control of concrete materials and concrete paving construction practices.
 - 2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:
 - a. Contractor's superintendent.

- b. Independent testing agency responsible for concrete design mixtures.
- c. Ready-mix concrete manufacturer.
- d. Concrete paving Subcontractor.
- e. Manufacturer's representative of stamped concrete paving system used for stamped detectable warnings.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.
- B. Material Certificates: For the following, from manufacturer:
 - 1. Cementitious materials.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Admixtures.
 - 4. Curing compounds.
 - 5. Applied finish materials.
 - 6. Bonding agent or epoxy adhesive.
 - 7. Joint fillers.
- C. Material Test Reports: For each of the following:
 - 1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- D. Field quality-control reports.

1.7 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

- B. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.9 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 - 3. Fog-spray forms, **steel reinforcement**, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 - 1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

- A. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from galvanized-steel wire into flat sheets.
- B. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.
- C. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A, plain steel.
- D. Reinforcing Bars: ASTM A615/A615M, Grade 60; deformed.
- E. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, Grade 60 deformed bars.
- F. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, Grade 60 deformed bars; assembled with clips.
- G. Plain-Steel Wire: ASTM A1064/A1064M, galvanized.
- H. Deformed-Steel Wire: ASTM A1064/A1064M.
- I. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A; coated, plain.
- J. Joint Dowel Bars: ASTM A615/A615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A767/A767M, Class I coating. Cut bars true to length with ends square and free of burrs.
- K. Epoxy-Coated, Joint Dowel Bars: ASTM A775/A775M; with ASTM A615/A615M, Grade 60 plain-steel bars.
- L. Tie Bars: ASTM A615/A615M, Grade 60; deformed.
- M. Hook Bolts: ASTM A307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

- N. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- O. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
- P. Zinc Repair Material: ASTM A780/A780M.

2.4 CONCRETE MATERIALS

- A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C150/C150M, white portland cement Type II.
- B. Normal-Weight Aggregates: ASTM C33/C33M, uniformly graded. Provide aggregates from a single source.
- C. Air-Entraining Admixture: ASTM C260/C260M.
- D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 - 1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 - 2. Retarding Admixture: ASTM C494/C494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
- E. Water: Potable and complying with ASTM C94/C94M.

2.5 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.

2.6 RELATED MATERIALS

- A. Joint Fillers: ASTM D1751, asphalt-saturated cellulosic fiber in preformed strips.

2.7 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
 - 2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.
- B. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
- C. Concrete Mixtures: Normal-weight concrete.
 - 1. Compressive Strength (28 Days): 4500 psi, 4000 psi, 3500 psi.

2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
 - 1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 - 2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..

3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
 1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
 2. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 INSTALLATION OF STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

- D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.
- F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963/D3963M.
- G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
 - 1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
 - 2. Provide tie bars at sides of paving strips where indicated.
 - 3. Butt Joints: Use epoxy-bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 - 5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 - 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.

5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
 - a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
 - a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.
 3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- H. Screed paving surface with a straightedge and strike off.
- I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

3.8 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.9 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 - 1. Elevation: 3/4 inch.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Surface: Gap below 10-foot- long; unlevelled straightedge not to exceed 1/2 inch.
 - 4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
 - 5. Lateral Alignment and Spacing of Dowels: 1 inch.
 - 6. Vertical Alignment of Dowels: 1/4 inch.
 - 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
 - 8. Joint Spacing: 3 inches.
 - 9. Contraction Joint Depth: Plus 1/4 inch, no minus.
 - 10. Joint Width: Plus 1/8 inch, no minus.
 - 11. ADA accessible pathways are to be constructed with a maximum of 5% running slope and 2% cross slope. There is no tolerance for exceeding these slopes.
 - 12. Landings within an ADA accessible pathway shall be sloped at 2% or less in all directions. There is no tolerance for exceeding these slopes.
 - 13. ADA accessible parking shall be sloped at 2% or less in all directions. There is no tolerance for exceeding these slopes.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or 5000 sq. ft. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
 - 5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 - 6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

- G. Concrete paving will be considered defective if it does not pass tests and inspections.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- I. Prepare test and inspection reports.

3.11 REPAIR AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.
2. Hot-applied joint sealants.
3. Joint-sealant backer materials.
4. Primers.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Concrete pavement joint sealants.
2. Joint-sealant backer materials.

B. Paving-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For Installer.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Entity that employs installers and supervisors who are trained and approved by manufacturer.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Testing: Performed by a qualified testing agency.

1.6 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 2. When joint substrates are wet.
 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backer materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 COLD-APPLIED JOINT SEALANTS

- A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D5893/D5893M, Type NS.
- B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D5893/D5893M, Type SL.
- C. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade NS, Class 25, for Use T.

2.3 HOT-APPLIED JOINT SEALANTS

- A. Hot-Applied, Single-Component Joint Sealant, Type I: ASTM D6690.
- B. Hot-Applied, Single-Component Joint Sealant, Type I or Type II: ASTM D6690.
- C. Hot-Applied, Single-Component Joint Sealant, Type I, II, or III: ASTM D6690.
- D. Hot-Applied, Single-Component Joint Sealant, Type IV: ASTM D6690.

2.4 JOINT-SEALANT BACKER MATERIALS

- A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

- B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
- D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.5 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

- B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.
- C. Install joint-sealant backers to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of joint-sealant backer materials.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backer materials.
 - 3. Remove absorbent joint-sealant backer materials that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants immediately following backer material installation, using proven techniques that comply with the following:
 - 1. Place joint sealants so they fully contact joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants in accordance with the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
 - 1. Remove excess joint sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING AND PROTECTION

- A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.
- B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

END OF SECTION 321373

SECTION 321723 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Painted markings applied to asphalt paving.
 - 2. Painted markings applied to concrete surfaces.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to marking asphalt paving or concrete surfaces including, but not limited to, the following:
 - a. Asphalt-paving or concrete-surface aging period before application of pavement markings.
 - b. Review requirements for protecting pavement markings, including restriction of traffic during installation period.

1.4 ACTION SUBMITTALS

- A. Product Data: Include technical data and tested physical and performance properties.
 - 1. Pavement-marking paint, acrylic.
- B. Shop Drawings:
 - 1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
 - 2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of AASHTO and the Standards and Specifications of the Maryland State Highway Administration for pavement-marking work.
 - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain pavement-marking paints from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design.

2.3 PAVEMENT-MARKING PAINT

- A. Pavement-Marking Paint, Acrylic: Acrylic, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952F, Type II, with drying time of less than [three] [45] minutes.
 - 1. Color: As indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that pavement-marking substrate is dry and in suitable condition to begin pavement marking in accordance with manufacturer's written instructions.
- B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow asphalt paving or concrete surfaces to age for a minimum of 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
 - 1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to asphalt paving or concrete surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.

3.3 PROTECTING AND CLEANING

- A. Protect pavement markings from damage and wear during remainder of construction period.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 321723

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Chain-link fences.
- 2. Swing gates.
- 3. Horizontal-slide gates.

- B. Related Requirements:

- 1. Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete equipment bases/pads for gate operators and controls and post footings.
- 2. Section 281500 "Access Control Hardware Devices" for gate controls.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Fence and gate posts, rails, and fittings.
 - b. Chain-link fabric, reinforcements, and attachments.
 - c. Gates and hardware.
 - d. Gate operators, including operating instructions and motor characteristics.

- B. Shop Drawings: For each type of fence and gate assembly.

- 1. Include plans, elevations, sections, details, and attachments to other work.
- 2. Include accessories, hardware, gate operation, and operational clearances.
- 3. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
- 4. Wiring Diagrams: For power, signal, and control wiring.

- C. Samples for Initial Selection: For each type of factory-applied finish.

- D. Samples for Verification: For each type of component with factory-applied finish, prepared on Samples of size indicated below:
 - 1. Polymer-Coated Components: In 6-inch (150-mm) lengths for components and on full-sized units for accessories.
- E. Delegated-Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.
- B. Product Certificates: For each type of chain-link fence, operator, and gate.
- C. Product Test Reports: For framework strength according to ASTM F1043, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.
- D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For gate operators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Emergency Access Requirements: According to requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure to comply with performance requirements.

- b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - c. Faulty operation of gate operators and controls.
2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design chain-link fence and gate frameworks.
- B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7.
 1. Design Wind Load: As indicated on Drawings.
 - a. Minimum Post Size: Determine according to ASTM F1043 for post spacing not to exceed **10 feet (3 m)** for Material Group IA, ASTM F1043, Schedule 40 steel pipe.
- C. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

2.2 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:
 1. Fabric Height: As indicated on Drawings.
 2. Steel Wire for Fabric: Wire diameter of **0.148 inch (3.76 mm)**.
 - a. Mesh Size: **1-3/4 inches (44 mm)**.
 - b. Zinc-Coated Fabric: ASTM A392, Type II, Class 2, **2.0 oz./sq. ft. (610 g/sq. m)** with zinc coating applied after weaving.
 3. Selvage: Twisted top and knuckled bottom.
 4. Polymer-Coated Fabric: ASTM F668, Class 2b over zinc-coated steel wire.
 - a. Color: Olive green, in accordance with ASTM F934.
 - 5.

2.3 FENCE FRAMEWORK

- A. Posts and Rails: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F1043 based on the following:
 - 1. Fence Height: As indicated on Drawings.
 - 2. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40.
 - 3. Horizontal Framework Members: Bottom rails according to ASTM F1043.
 - 4. Brace Rails: ASTM F1043.
 - 5. Metallic Coating for Steel Framework:
 - a. Type A: Not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating according to ASTM A123/A123M or 4.0-oz./sq. ft. (1.22-kg/sq. m) zinc coating according to ASTM A653/A653M.

2.4 TENSION WIRE

- A. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire according to ASTM A817 or ASTM A824, with the following metallic coating:
 - 1. Type II: Zinc coated (galvanized) by hot-dip process, with the following minimum coating weight:
 - a. Matching chain-link fabric coating weight.

2.5 SWING GATES

- A. General: ASTM F900 for gate posts and single swing gate types.
 - 1. Gate Leaf Width: 36 inches (914 mm).
 - 2. Framework Member Sizes and Strength: Based on gate fabric height of more than 72 inches (1830 mm).
- B. Pipe and Tubing:
 - 1. Zinc-Coated Steel: ASTM F1043 and ASTM F1083; protective coating and finish to match fence framework.
- C. Frame Corner Construction: Welded.
- D. Hardware:
 - 1. Hinges: 180-degree outward swing.
 - 2. Latch: Permitting operation from both sides of gate.
 - 3. Lock: Electromechanical exit device for outdoor use, with card reader access.
 - 4. Closer: Hydraulic closer rated for outdoor use.

5. Stainless steel guard panel, minimum 24" by width of gate, with minimum 12" x 24" guards on fixed fencing either side of gate, to prevent tampering. Rounded edges and non-protruding fasteners.

2.6 HORIZONTAL-SLIDE GATES

- A. General: ASTM F1184 for gate posts and single sliding gate types. Provide automated vehicular gates according to ASTM F2200.
 1. Classification: Type II Cantilever Slide, Class 1 with external roller assemblies.
 - a. Gate Frame Width and Height: More than 48 inches (1220 mm) wide by any height.
- B. Pipe and Tubing:
 1. Zinc-Coated Steel: Protective coating and finish to match fence framework.
- C. Frame Corner Construction: Welded.
- D. Hardware:
 1. Hangers, Roller Assemblies, and Stops: Fabricated from galvanized malleable iron.
 2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
 3. Lock: Manufacturer's standard internal device.

2.7 FITTINGS

- A. Provide fittings according to ASTM F626.
- B. Post Caps: Provide for each post.
 1. Provide line post caps with loop to receive tension wire or top rail.
- C. Rail and Brace Ends: For each gate, corner, pull, and end post.
- D. Rail Fittings: Provide the following:
 1. Rail Clamps: Line and corner boulevard clamps for connecting bottom rails to posts.
- E. Tension and Brace Bands: Pressed steel.
- F. Tension Bars: Steel, length not less than 2 inches (50 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
- G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

- H. Tie Wires, Clips, and Fasteners: According to ASTM F626.
 - 1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:
 - a. Hot-Dip Galvanized Steel: **0.148-inch- (3.76-mm-)** diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.
- I. Finish:
 - 1. Metallic Coating for Pressed Steel or Cast Iron: Not less than **1.2 oz./sq. ft. (366 g/sq. m)** of zinc.

2.8 GATE OPERATORS

- A. Operators: Factory-assembled, automatic, gate-operating system designed for gate size, type, weight, and frequency of use. Control system shall have characteristics suitable for Project conditions, with control stations, safety devices, and weatherproof enclosures.
 - 1. Operator design shall allow for removal of cover or motor without disturbing limit-switch adjustment and without affecting auxiliary emergency operation.
 - 2. Electronic components shall have built-in troubleshooting diagnostic feature.
 - 3. Unit shall be designed and wired for both right-hand/left-hand opening, permitting universal installation.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. UL Standard: Manufacture and label gate operators according to UL 325.
- D. Motors: Comply with NEMA MG 1.
 - 1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of **3300 feet (1000 m)** above sea level.
 - 2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
 - 3. Service Factor: 1.15.
 - 4. Electrical Characteristics:
 - a. Horsepower: 1.
 - b. Voltage: 115 V ac, single phase, 60 hertz.
- E. Gate Operators: Equipment base/pad mounted and as follows:
 - 1. Mechanical Slide Gate Operators:
 - a. Duty: Medium duty, commercial/industrial.
 - b. Gate Speed: Minimum **45 feet (13.7 m)** per minute.

- c. Maximum Gate Weight: 600 lb (272 kg).
 - d. Frequency of Use: 10 cycles per hour.
 - e. Operating Type: Roller chain, with manual release.
 - f. Drive Type: Enclosed worm gear and chain-and-sprocket reducers, roller-chain drive.
- F. Controls: Electric controls separated from gate and motor and drive mechanism, with NEMA 250, Type 3R enclosure for pedestal mounting and with space for additional optional equipment.
- G. Control Devices:
 - 1. Card Reader: Functions only when authorized card is presented. Programmable, magnetic multiple-code system.
 - a. Reader Type: Proximity.
 - b. Features: Capable of monitoring and auditing gate activity, integrated with Owner's card access system.
- H. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:
 - 1. Action: Reverse gate in both opening and closing cycles and hold until clear of obstruction.
 - 2. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
- I. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully open and fully closed positions.
- J. Emergency Release Mechanism: Quick-disconnect release of operator drive system, permitting manual operation if operator fails. Control circuit power is disconnected during manual operation.
 - 1. Type: Mechanical device, key, or crank-activated release.
- K. Operating Features:
 - 1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability for monitoring and auditing gate activity. Provide unit that is isolated from voltage spikes and surges.
 - 2. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
 - 3. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
 - 4. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
- L. Accessories:
 - 1. Battery Backup System: Battery-powered drive and access-control system, independent of primary drive system.

- a. Fail Safe: Gate opens and remains open until power is restored.
 - b. Fail Secure: Gate cycles on battery power, then fail safe when battery is discharged.
2. External electric-powered solenoid lock with delay timer allowing time for lock to release before gate operates.
 3. Fire box.
 4. Equipment Bases/Pads: Cast-in-place or precast concrete, depth not less than 12 inches (300 mm), dimensioned and reinforced according to gate-operator component manufacturer's written instructions and as indicated on Drawings.

2.9 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

2.10 GROUNDING MATERIALS

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.
 1. Connectors for Below-Grade Use: Exothermic welded type.
 2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches (16 by 2440 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
 1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of **500 feet (152 m)** or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

- A. Install chain-link fencing according to ASTM F567 and more stringent requirements specified.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Exposed Concrete: Extend **2 inches (50 mm)** above grade; shape and smooth to shed water.
- D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more. For runs exceeding **500 feet (152 m)**, space pull posts an equal distance between corner or end posts.
- E. Line Posts: Space line posts uniformly at **96 inches (2440 mm)** o.c.
- F. Post Bracing and Intermediate Rails: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
- G. Tension Wire: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with **0.120-inch- (3.05-mm-)** diameter hog rings of same material and finish as fabric wire, spaced a maximum of **24 inches (610 mm)** o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
 - 1. Extended along top of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within **6 inches (152 mm)** of bottom of fabric and tie to each post with not less than same diameter and type of wire.
- H. Bottom Rails: Secure to posts with fittings.
- I. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave **1-inch (25-mm)** bottom clearance between finish grade or surface and bottom selvage, except as noted below.

Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

1. Buried Fabric: Where indicated at kennel enclosures, bury the bottom **12 inches (300 mm)** of a continuous **18-inch- (457-mm-)** wide, polymer-coated chain-link fabric in a vertical trench below the fencing; overlap above-grade fence fabric **6 inches (152 mm)** and secure to bottom rail with tie wires. Backfill and compact trench.

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- K. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than **15 inches (380 mm)** o.c.

- L. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at **12 inches (300 mm)** o.c. and to braces at **24 inches (610 mm)** o.c.

- M. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side.

3.4 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation. Install guard panels on secure side of gate and fence.

3.5 GATE-OPERATOR INSTALLATION

- A. Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
- B. Excavation: Hand-excavate holes for posts, pedestals, and equipment bases/pads, in firm, undisturbed soil to dimensions and depths and at locations according to gate-operator component manufacturer's written instructions and as indicated.
- C. Ground electric-powered motors, controls, and other devices according to NFPA 70 and manufacturer's written instructions.

3.6 GROUNDING AND BONDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Fence and Gate Grounding:

1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.
2. Install ground rods and connections at maximum intervals of **750 feet (225 m)**.
3. Ground fence on each side of gates and other fence openings.
 - a. Bond metal gates to gate posts.
 - b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least **18 inches (457 mm)** below finished grade.
- C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of **150 feet (45 m)** on each side of crossing.
- D. Fences Enclosing Electrical Power Distribution Equipment: Ground according to IEEE C2 unless otherwise indicated.
- E. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is **6 inches (152 mm)** below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.
- F. Connections:
 1. Make connections with clean, bare metal at points of contact.
 2. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 4. Make above-grade ground connections with mechanical fasteners.
 5. Make below-grade ground connections with exothermic welds.
 6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- G. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor according to NFPA 780.
- H. Comply with requirements in Section 264113 "Lightning Protection for Structures."

3.7 FIELD QUALITY CONTROL

- A. Grounding Tests: Comply with requirements in Section 264113 "Lightning Protection for Structures."
- B. Prepare test reports.

3.8 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Automatic Gate Operator: Energize circuits to electrical equipment and devices, start units, and verify proper motor rotation and unit operation.
 - 1. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
 - 2. Test and adjust operators, controls and safety devices. Replace damaged and malfunctioning controls and equipment.
 - 3. Lubricate operator and related components.
- C. Lubricate hardware and other moving parts.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 323113

SECTION 329113 - SOIL PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes planting soils specified by composition of the mixes.
- B. Related Requirements:
 - 1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
 - 2. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
 - 3. Section 329300 "Plants" for placing planting soil for plantings.

1.3 DEFINITIONS

- A. AAPFCO: Association of American Plant Food Control Officials.
- B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
- C. CEC: Cation exchange capacity.
- D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
- E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- F. Imported Soil: Soil that is transported to Project site for use.
- G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.
- H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

- I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.
- J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
- K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
- M. SSSA: Soil Science Society of America.
- N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- Q. USCC: U.S. Composting Council.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include recommendations for application and use.
 - 2. Include test data substantiating that products comply with requirements.
 - 3. Include sieve analyses for aggregate materials.
 - 4. Material Certificates: For each type of imported soil, and soil amendment and fertilizer before delivery to the site, according to the following:
 - a. Manufacturer's qualified testing agency's certified analysis of standard products.
 - b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.

- c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For each testing agency.
- B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.
- C. Field quality-control reports.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.
 1. Multiple Laboratories: At Contractor's option, work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.

1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil, imported soil.
- B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
 1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.9 SOIL-SAMPLING REQUIREMENTS

- A. General: Extract soil samples according to requirements in this article.
- B. Sample Collection and Labeling: Have samples taken and labeled by Contractor under the direction of the testing agency.
 1. Number and Location of Samples: Minimum of three representative soil samples from varied locations for each soil to be used or amended for landscaping purposes.
 2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."

3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.10 TESTING REQUIREMENTS

- A. General: Perform tests on soil samples according to requirements in this article.
- B. Physical Testing:
 1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
 - a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
 - b. Hydrometer Method: Report percentages of sand, silt, and clay.
 2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
 3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
 4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D698 (Standard Proctor).
- C. Chemical Testing:
 1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
 2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."
 3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
 4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.
- D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT NEC-67, including the following:
 1. Percentage of organic matter.
 2. CEC, calcium percent of CEC, and magnesium percent of CEC.

3. Soil reaction (acidity/alkalinity pH value).
 4. Buffered acidity or alkalinity.
 5. Nitrogen ppm.
 6. Phosphorous ppm.
 7. Potassium ppm.
 8. Manganese ppm.
 9. Manganese-availability ppm.
 10. Zinc ppm.
 11. Zinc availability ppm.
 12. Copper ppm.
 13. Sodium ppm.
 14. Soluble-salts ppm.
 15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
 16. Other deleterious materials, including their characteristics and content of each.
- E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
- F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.
1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inch depth of soil.
 2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inch depth of soil.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
- B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Do not move or handle materials when they are wet or frozen.
 4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

- A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.
- B. Planting-Soil Type: Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil. Blend existing, on-site surface soil with the following soil amendments and fertilizers in the quantities based on soil test results.
- C. Planting-Soil Type: Imported, naturally formed soil from off-site sources and consisting of sandy loam, loam, loamy sand according to USDA textures; and modified to produce viable planting soil.
 - 1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from agricultural land, bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.
 - 2. Additional Properties of Imported Soil before Amending: Soil reaction of pH 6 to 7 and minimum of 4 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
 - 3. Unacceptable Properties: Clean soil of the following:
 - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
 - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.
 - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 2 inches in any dimension.
 - 4. Amended Soil Composition: Blend imported, unamended soil with the following soil amendments and fertilizers in quantities to produce planting soil.

2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 - 1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.

2. Class: O, with a minimum of 95 percent passing through a No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.
 3. Form: Provide lime in form of ground dolomitic limestone.
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Perlite: Horticultural perlite, soil amendment grade.
- E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.
- F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C33/C33M.

2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
1. Feedstock: Limited to leaves.
 2. Reaction: pH of 5.5 to 8.
 3. Soluble-Salt Concentration: Less than 4 dS/m.
 4. Moisture Content: 35 to 55 percent by weight.
 5. Organic-Matter Content: Minimum 30 percent of dry weight.
 6. Particle Size: Minimum of 98 percent passing through a 1-inch sieve.

Retain "Sphagnum Peat" or "Muck Peat" Paragraph below, or both, if required; sphagnum peat is an acidic peat; muck peat has a neutral pH.

- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of maximum 5 dS/m.
- C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 6 to 7.5, a soluble-salt content measured by electrical conductivity of maximum 5 dS/m, having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.
- D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.4 FERTILIZERS

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of [20] [33] [50] percent available phosphoric acid.
- B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
 - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
 - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

PART 3 - EXECUTION

3.1 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.
- C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

- A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches and stockpile until amended.
- B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

- C. Unsuitable Materials: Clean soil to contain a maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.
- D. Screening: Pass unamended soil through a 2-inch sieve to remove large materials.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 8 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.
- C. Mixing: Spread unamended soil to total depth of 4 inches, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
 - 1. Amendments: Apply soil amendments, except compost, and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
 - a. Mix lime and sulfur with dry soil before mixing fertilizer.
 - b. Mix fertilizer with planting soil no more than seven days before planting.
 - 2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698 and tested in-place.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 8 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.
- C. Application: Spread planting soil to total depth of 4 inches, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
1. Lifts: Apply planting soil in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 BLENDING PLANTING SOIL IN PLACE

- A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of 6 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Apply soil amendments, except compost, and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.
1. Mix lime and sulfur with dry soil before mixing fertilizer.
 2. Mix fertilizer with planting soil no more than seven days before planting.
- D. Compaction: Compact blended planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.6 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

- A. Application: Apply 4 inches of compost to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
 - 1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D698. Space tests at no less than one for each 2000 sq. ft. of in-place soil or part thereof.
- C. Soil will be considered defective if it does not pass tests[and inspections].
- D. Prepare test and inspection reports.
- E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.8 PROTECTION

- A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."
- B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Vehicle traffic.
 - 4. Foot traffic.
 - 5. Erection of sheds or structures.
 - 6. Impoundment of water.
 - 7. Excavation or other digging unless otherwise indicated.
- C. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.9 CLEANING

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

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1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 329113

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Seeding.
- 2. Hydroseeding.

- B. Related Requirements:

- 1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" and drawing designations for planting soils.
- E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- C. Product Certificates: For fertilizers, from manufacturer.
- D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
 - 1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
 - 2. Experience: Five years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. Personnel Certifications: Installer's [field supervisor] [personnel assigned to the Work] shall have certification in [one of] [all of] the following categories from the National Association of Landscape Professionals:
 - a. Landscape Industry Certified Technician - Exterior.
 - b. Landscape Industry Certified Lawn Care Manager.
 - c. Landscape Industry Certified Lawn Care Technician.
 - 5. Pesticide Applicator: State licensed, commercial.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.
- C. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.

1.9 FIELD CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.
 - 1. Spring Planting: March 01 to May 15.
 - 2. Fall Planting: August 15 to October 15.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:
 - 1. Quality, State Certified: State-certified seed of grass species as listed below for solar exposure.
 - 2. Quality, Non-State Certified: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
 - 3. Sun and Partial Shade, Cool-Season Grass: Proportioned by weight as follows:
 - a. 50 percent Kentucky bluegrass (*Poa pratensis*).
 - b. 30 percent chewings red fescue (*Festuca rubra* variety).

- c. 10 percent perennial ryegrass (*Lolium perenne*).
- d. 10 percent redtop (*Agrostis alba*).

2.2 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition:
 - a. 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
 - b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition:
 - a. 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
 - b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.3 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.
- C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.
- D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of less than 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 to 60 percent of dry weight.
 - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

- E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
- G. Asphalt Emulsion: ASTM D977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.4 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade or Blend planting soil in place.
 - 1. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. Prepare area as specified in "Turf Area Preparation" Article.
- B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.
- C. Fill cells of erosion-control mat with planting soil and compact before planting.
- D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 7 to 8 lb/1000 sq. ft..
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.
- F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
 - 2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft.. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.
- G. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.6 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, commercial fertilizer and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
 - 1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
 - 2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3.7 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
 - 1. Mow Kentucky bluegrass to a height of 2 to 3 inches.

- D. Turf Postfertilization: Apply slow-release fertilizer after initial mowing and when grass is dry.
 - 1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.8 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
 - 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
 - 2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
 - 3. Satisfactory Plugged Turf: At end of maintenance period, the required number of plugs has been established as well-rooted, viable patches of grass, and areas between plugs are free of weeds and other undesirable vegetation.

4. Satisfactory Sprigged Turf: At end of maintenance period, the required number of sprigs has been established as well-rooted, viable plants, and areas between sprigs are free of weeds and other undesirable vegetation.

- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.9 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.10 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

3.11 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
 1. Seeded Turf: From date of installation to end of warranty period.
 - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

END OF SECTION 329200

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Plants.
2. Tree stabilization.
3. Tree-watering devices.

- B. Related Requirements:

1. Section 015639 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.3 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.
- D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.
- E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when

removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

- F. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
- G. Finish Grade: Elevation of finished surface of planting soil.
- H. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
- I. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- J. Planting Area: Areas to be planted.
- K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" for drawing designations for planting soils.
- L. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- M. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- N. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- O. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 COORDINATION

- A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
 - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
- 2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

- B. Samples for Verification: For each of the following:

- 1. Trees and Shrubs: Three Samples of each variety and size. Maintain approved Samples on-site as a standard for comparison.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

- B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

- 1. Manufacturer's certified analysis of standard products.
- 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

- C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

- D. Sample Warranty: For special warranty.

1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
 2. Experience: Five years' experience in landscape installation.
 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the National Association of Landscape Professionals:
 - a. Landscape Industry Certified Technician - Exterior.
 - b. Landscape Industry Certified Interior.
 - c. Landscape Industry Certified Horticultural Technician.
 5. Pesticide Applicator: State licensed, commercial.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
1. Selection of plants purchased under allowances is made by Architect, who tags plants at their place of growth before they are prepared for transplanting.
- C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Deliver bare-root stock plants within 24 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.
- D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- E. Handle planting stock by root ball.
- F. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.
- G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.
- H. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
 - 1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
 - 2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 - 3. Do not remove container-grown stock from containers before time of planting.
 - 4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.11 FIELD CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. September 1 to June 15, whenever soil is not frozen or excessively wet.
- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.12 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
 - b. Structural failures including plantings falling or blowing over.
 - c. Faulty performance of tree stabilization.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Periods: From date of planting completion.
 - a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months or completion of a single complete growing season, whichever is greater.
 - b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months or completion of a single complete growing season, whichever is greater.
 - 3. Include the following remedial actions as a minimum:
 - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
 - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
 - d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
 - 1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.
 - 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- D. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.
- E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 FERTILIZERS

- A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
 - 1. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.3 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood.
 2. Size Range: 3 inches maximum, 1/2 inch minimum.
 3. Color: Natural.
- B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through a 1-inch sieve; soluble-salt content of 2 to 5 dS/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
1. Organic Matter Content: 50 to 60 percent of dry weight.
 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- C. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of the following type, size range, and color:
1. Type: Rounded riverbed gravel or smooth-faced stone.
 2. Size Range: 1-1/2 inches maximum, 3/4 inch minimum.
 3. Color: Readily available natural gravel color range.

2.4 PESTICIDES

- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.5 TREE-STABILIZATION MATERIALS

- A. Trunk-Stabilization Materials:
1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
 2. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
 3. Guy Cables: Five-strand, 3/16-inch- diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 3 inches long, with two 3/8-inch galvanized eyebolts.
 4. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.
 5. Proprietary Staking-and-Guying Devices: Proprietary stake or anchor and adjustable tie systems to secure each new planting by plant stem; sized as indicated and according to manufacturer's written recommendations.

B. Root-Ball Stabilization Materials:

1. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated; stakes pointed at one end.
2. Wood Screws: ASME B18.6.1.
3. Proprietary Root-Ball Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball and that do not encircle the trunk; sized according to manufacturer's written recommendations unless otherwise indicated.

2.6 TREE-WATERING DEVICES

- A. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over an extended time period; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

2.7 MISCELLANEOUS PRODUCTS

- A. Burlap: Non-synthetic, biodegradable.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
 3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Placing Planting Soil: Place and mix planting soil in-place over exposed subgrade.
- C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits.
 - 1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
 - 2. Excavate approximately three times as wide as ball diameter.
 - 3. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
 - 4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
 - 5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 - 6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 - 7. Maintain supervision of excavations during working hours.
 - 8. Keep excavations covered or otherwise protected when unattended by Installer's personnel.

9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.
- B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.
- C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
- D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
 1. Backfill: Planting soil for trees, use excavated soil for backfill.
 2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
 5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
 1. Backfill: Planting soil for trees, use excavated soil for backfill.
 2. Carefully remove root ball from container without damaging root ball or plant.
 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
 5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 MECHANIZED TREE-SPADE PLANTING

- A. Trees may be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.
- B. Use the same tree spade to excavate the planting hole as will be used to extract and transport the tree.
- C. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.
- D. Cut exposed roots cleanly during transplanting operations.
- E. Plant trees following procedures in "Tree, Shrub, and Vine Planting" Article.
- F. Where possible, orient the tree in the same direction as in its original location.

3.7 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.
- C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- D. Do not apply pruning paint to wounds.

3.8 TREE STABILIZATION

- A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying:
 - a. Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend one-third of trunk height above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
 2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
- B. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Drawings. Stake and guy trees more than 14 feet in height and more than 3 inches in caliper unless otherwise indicated.
 1. Site-Fabricated, Staking-and-Guying Method: Install no fewer than three guys spaced equally around tree.
 - a. Securely attach guys to stakes 30 inches long, driven to grade. Adjust spacing to avoid penetrating root balls or root masses. Provide turnbuckle for each guy wire and tighten securely.
 - b. For trees more than 6 inches in caliper, anchor guys to wood deadmen buried at least 36 inches below grade. Provide turnbuckle for each guy wire and tighten securely.
 - c. Support trees with bands of flexible ties at contact points with tree trunk and reaching to turnbuckle. Allow enough slack to avoid rigid restraint of tree.
 - d. Attach flags to each guy wire, 30 inches above finish grade.
 2. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.
- C. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball unless otherwise indicated.
 1. Wood Hold-Down Method: Place vertical stakes against side of root ball and drive them into subsoil; place horizontal wood hold-down stake across top of root ball and screw at each end to one of the vertical stakes.
 - a. Install stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation. Saw stakes off at horizontal stake.
 - b. Install screws through horizontal hold-down and penetrating at least 1 inch into stakes. Predrill holes if necessary to prevent splitting wood.
 - c. Install second set of stakes on other side of root trunk for larger trees.
 2. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.9 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
- B. Use planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.
- E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.10 PLANTING AREA MULCHING

- A. Mulch backfilled surfaces of planting areas and other areas indicated.
 - 1. Trees and Treelike Shrubs in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 36-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.
 - 2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch extending 12 inches beyond edge of individual planting pit or trench, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.
 - 3. Mineral Mulch in Planting Areas: Apply 3-inch average thickness of mineral mulch extending 12 inches beyond edge of individual planting pit or trench, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.11 INSTALLATION OF SLOW-RELEASE WATERING DEVICE

- A. Provide one device for each tree.
- B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

3.12 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or

vertical position, and performing other operations as required to establish healthy, viable plantings.

- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.13 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.14 REPAIR AND REPLACEMENT

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.
 - 1. Submit details of proposed pruning and repairs.
 - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
 - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.
- B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

3.15 CLEANING AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.
- E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.16 MAINTENANCE SERVICE

- A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
 - 1. Maintenance Period: From date of installation until end of warranty period.
- B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
 - 1. Maintenance Period: From date of installation until end of warranty period.

END OF SECTION 329300

SECTION 331415 - SITE WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water-distribution piping and related components outside the building for combined domestic water service and fire-suppression water service and terminated 5 ft. from building. Terminate water-service piping with appropriate fitting for extension by Division 22.

1.2 DEFINITIONS

- ##### A. PE: Polyethylene plastic.

1.3 ACTION SUBMITTALS

- ##### A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- ##### A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.
- ##### B. Field Quality-Control Submittals:
1. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- ##### A. Operation and Maintenance Data: For each type of product indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- ##### A. Preparation for Transport: Prepare piping, valves, meters, backflow prevention devices, and fire hydrants according to the following:
1. Ensure that piping, valves, meters, backflow prevention devices, and fire hydrants are dry and internally protected against rust and corrosion.

2. Protect threaded ends and flange faces against damage.
 3. Set piping, valves, meters, backflow prevention devices, and fire hydrants in best position for handling and to prevent rattling.
- B. During Storage: Use precautions for piping, valves, meters, backflow prevention devices, and fire hydrants according to the following:
1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle products if size requires handling by crane or lift. Rig products to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service in accordance with requirements indicated:
1. Notify Architect no fewer than two days in advance of proposed interruption of service.
 2. Do not proceed with interruption of water-distribution service without Architect's written permission.

1.8 COORDINATION

- A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.

- B. Comply with standards of authorities having jurisdiction for domestic water-service piping, including materials, installation, testing, and disinfection.
- C. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
- D. Piping materials to bear label, stamp, or other markings of specified testing agency.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
- F. Comply with ASTM F645 for selection, design, and installation of thermoplastic water piping.
- G. Comply with FM Approvals' "Approval Guide" and/or UL's "Fire Protection Equipment Directory" for fire-suppression water-service products.
- H. Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-suppression water-service piping.
- I. All piping and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372 or are certified in compliance with NSF 61/NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPING MATERIALS

- A. Comply with requirements in "Piping Applications" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and service sizes.
- B. Potable-water piping and components comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.3 DUCTILE-IRON PIPE AND FITTINGS

- A. Push-on-Joint, Ductile-Iron Pipe:
 - 1. AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 2. AWWA C104/A21.4 cement mortar-lined.
- B. Push-on-Joint, Ductile-Iron Fittings:
 - 1. AWWA C110, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
 - 2. Gaskets: AWWA C111/A21.11, rubber.

3. AWWA C104/A21.4 cement mortar-lined.

C. Flanges: ASME 16.1, Class 125, cast iron.

2.4 PIPING JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series.

B. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

C. Gaskets for Ferrous Piping and Copper-Alloy Tubing: ASME B16.21, asbestos free.

D. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.5 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.6 ENCASEMENT FOR PIPING

A. Standards: ASTM A674 or AWWA C105/A21.5.

B. Form: Sheet.

C. Material: Linear low-density PE film of 0.008-inch minimum thickness.

D. Color: Black.

2.7 GATE VALVES

A. Gate Valves - AWWA, Cast Iron:

1. Source Limitations: Obtain gate valves - AWWA, cast iron, from single manufacturer.
2. Gate Valves - Nonrising Stem, Resilient Seated: Cast- or ductile-iron body and bonnet, with bronze or cast- or ductile-iron gate, resilient seats, bronze stem, and stem nut.

- a. Standards: AWWA C509 or AWWA C515.
- b. Minimum Pressure Rating: 200 psig.
- c. End Connections: Mechanical joint, flanged, threaded, or push on.
- d. Interior Coating: Complying with AWWA C550.

2.8 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Tapping-Sleeve Assemblies: Sleeve and valve compatible with drilling machine.
 - 1. Source Limitations: Obtain tapping-sleeve assemblies from single manufacturer.
 - 2. Standard: MSS SP-60.
 - 3. Tapping Sleeve: Cast- or ductile-iron or stainless steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
 - 4. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.
- B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.
 - 1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
- C. Indicator Posts: UL 789, FM Global approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with excavating, trenching, and backfilling requirements in Section 312000 "Earth Moving."

3.2 PIPING APPLICATIONS

- A. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.
- B. Do not use flanges or unions for underground piping.
- C. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- D. Underground Combined Water-Service and Fire-Service-Main Piping NPS 6 to NPS 12 to be the following:
 - 1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed joints.

3.3 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FM Global, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

3.4 INSTALLATION OF PIPING

- A. Water-Main Connection:
 - 1. Tap water main in accordance with requirements of water utility company and of size and in location indicated.
- B. Make connections larger than NPS 2 with tapping machine according to the following:
 - 1. Install tapping sleeve and tapping valve in accordance with MSS SP-60.
 - 2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
 - 3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
 - 4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.
- C. Comply with NFPA 24 for fire-service-main piping materials and installation.
- D. Install ductile-iron, water-service piping in accordance with AWWA C600 and AWWA M41.
- E. Bury piping with depth of cover over top at least 48 inches, with top at least 12 inches below level of maximum frost penetration.
- F. Extend water-service and fire-suppression water-service piping and connect to water-supply source and building water-piping and fire-suppression piping systems at outside face of building wall in locations and pipe sizes indicated.
 - 1. Terminate water-service and fire-suppression water-service piping at building wall until building water-piping and fire-suppression piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building water-piping and fire-suppression piping systems when those systems are installed.
- G. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
- H. Comply with Section 221116 "Domestic Water Piping" for potable-water piping inside the building.

3.5 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:

1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.

3.6 INSTALLATION OF ANCHORAGE

- A. Anchorage: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 1. Concrete thrust blocks.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: In accordance with AWWA C600.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 INSTALLATION OF VALVES

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
- C. UL-Listed or FM Global-Approved Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- D. UL-Listed or FM Global-Approved Valves Other Than Gate Valves: Comply with NFPA 24.
- E. MSS Valves: Install as component of connected piping system.
- F. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves.
- G. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete" for support of valves and piping not direct buried.

3.8 CONNECTIONS

- A. Connect water-distribution piping to utility water main. Use tapping sleeve and tapping valve.
- B. Connect water-distribution piping to interior domestic water and fire-suppression piping.
- C. Connect waste piping from concrete vault drains to storm-drainage system. See Section 334400 "Storm Utility Drainage Piping" for connection to storm-sewer piping.

- D. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.9 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
 - 1. Increase pressure in 50 psig increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to 0 psig. Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
- C. Prepare reports of testing activities.

3.10 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

3.11 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
 - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
 - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
 - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
 - b. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
 - c. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- B. Prepare reports of purging and disinfecting activities.

Maryland State Police
Tactical Administration Center
PA-745-210-001
100% CD Specifications

END OF SECTION 331415

SECTION 334199 - STORMWATER MANAGEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Stormwater Management Plans and Report approved (green stamped) by the Maryland Department of the Environment.

1.2 SUMMARY

- A. Section includes requirements for the inspection of stormwater management (SWM) facilities during construction activities as specified and submission of a stormwater management facility as-built certification package for each stormwater management facility constructed to the Maryland Department of the Environment within 45 calendar days of completing construction of all stormwater management facilities.

1.3 INFORMATION SUPPLIED BY THE OWNER

- A. Upon written request, the Owner will provide CADD files in AutoCAD format and the approved Final SWM Report in PDF format to facilitate completion of the SWM facility as-built certification package.

1.4 STORMWATER MANAGEMENT CERTIFYING ENGINEER

- A. The Contractor shall engage a Maryland registered Professional Engineer to perform the duties in this specification section.
- B. The Certifying Engineer is responsible for assembling and certifying the SWM certification package. Duties include adequately documenting that the SWM facilities have been constructed as specified and performing inspections during pertinent construction activities for the SWM facilities and practices. The Certifying Engineer shall be a Professional Engineer (P.E.) registered and licensed in the State of Maryland and who has at least three years of experience in SWM facility design and SWM facility construction.
- C. The Certifying Engineer shall have the option to use designees, who are under the direct supervision of the Certifying Engineer, to perform the following duties on behalf of the Certifying Engineer.
 - 1. Documenting that the SWM facilities have been constructed as specified including writing activity inspection reports, taking photographs, and obtaining copies of material approvals and material test reports.

2. Performing inspections during pertinent construction activities for the SWM facilities and practices, completing the pertinent portions of the SWM facility as-built certification data tables.
3. When the Certifying Engineer elects to use designees, submit the names and resumes indicating their experience in the design and inspection of SWM facilities, of those designees authorized by the Certifying Engineer to Certifying Engineer. Only authorized designees may represent the Certifying Engineer for the limited duties specified.

1.5 STORMWATER MANAGEMENT FACILITY AS-BUILT CERTIFICATION PACKAGE

- A. The SWM facility as-built certification package contains documentation that verifies that all SWM facilities and practices on the Contract have been constructed as specified or are functionally equivalent to the designs in the approved SWM Report.
- B. The SWM facility as-built certification shall include the following for each SWM facility in the Contract, presented neatly and legibly, and organized in an easy to follow format.
 1. SWM facility construction inspection reports. The inspection reports shall include the following:
 - a. The SWM facility deification number and type of SWM facility or practice.
 - b. The date and location of the activity.
 - c. Photographs, taken during inspections, that clearly show the construction activities as listed on the pertinent SWM facility as-built data tables, with narrative descriptions of what appears in the photographs, the dates of the photographs were taken, and the locations.
 - d. Verification of whether SWM facility as-built construction is as specified, noting any deviations from the Contract Documents and how the deviations have been addressed.
 2. Photographs of SWM facilities and practices after all landscaping has been installed and established, with narrative descriptions of what appears in the photographs.
 3. Copies of pertinent material approval forms.
 4. Copies of pertinent materials and installation test reports and results.
 5. Completed as-built certifications data tables.
 6. Green line as-built surveys of the SWM facilities and practices signed and sealed by a Professional Land Surveyor (PLS) who is registered and licensed in the State of Maryland. The as-built survey data shall be overlaid on the appropriate Contract plan sheet(s) and profile sheets, at the same scale and datum, and are coordinately correct. The as-built survey data shall be green in color, clearly legible and easily distinguishable from the Contract Document information. The SWM facility as-built surveys shall include the following:

- a. Contours. One-foot contour intervals or otherwise match the contour intervals shown in the Contract Documents. Contours shall cover the entire footprint of the SWM facility or practice as well as inflow and outflow conveyances when ditches or similar features convey runoff into or out of SWM facilities and practices.
 - b. Drainage Structures. Includes all drainage structures within the footprint of the SWM facility, including but not limited to inlets, manholes, flow splitters, risers, weirs, end sections, headwalls, and end walls. As-built data shall include but is not limited to top of structure elevations, structure lengths, and structure widths; pipe inverts; pipe sizes, materials, and flow directions; orifice elevations; opening sizes; weir dimensions and elevations; check dam locations and dimensions; grates; and trash racks.
 - c. Riprap and Aggregate. Includes dimensions of riprap and other areas within the footprint of the SWM facility and practice that show a surface layer of aggregate or riprap, including forebays.
 - d. Embankment Information. Includes embankment heights, widths, and elevations; clay core locations, dimensions, and elevations; cut-off trench locations, dimensions, and elevations; pertinent filter diaphragm information; and pertinent pipe cradle information. Data that cannot be obtained from a field survey shall be provided by the Certifying Engineer for inclusion with the SWM facility as-built survey.
 - e. SWM Facility Maintenance Access Roads.
 - f. Fences. Includes fence that surrounds the footprint of the SWM facility or practice.
 - g. SWM Facility Profiles. Includes an overlay of green line as-built data on SWM facility profiles and typical sections including but not limited to check dam spacing, check dam top elevations, check dam dimensions, invert elevations, subdrain sizes, subdrain materials, aggregate and soil thicknesses, material types, clay core dimensions, and cut-off trench dimensions. Data that cannot be obtained from a field survey shall be provided by the Certifying Engineer for inclusion with the SWM facility as-built survey.
 - h. Certification. Seal, signature, license number, and date of license expiration of the PLS who completes the SWM facility as-built survey.
7. Applicable supporting computations demonstrating that the functionality of the SWM facilities and practices meet the approved designs as presented in the approved SWM Report. This is only necessary when tolerances are not met and shall include but is not limited to water surface elevations, freeboard, storage volumes, depths, and other pertinent SWM functionality data that demonstrates the SWM facility performances meets the approved design.
 8. A narrative of justification for as-built deviations in SWM facilities and practices.
 9. Seal, signature, license number, and date of license expiration of the Certifying Engineer.

1.6 SUBMITTALS AND APPROVAL PROCESS

1. Submittals and Approval Process
 - a. Copies of all submission made to the MDE shall be provided to the Owner and Architect.

- b. Partial submittals of the SWM facility as-built package may be made as construction of each individual SWM facility and practice is completed. Otherwise, submit the entire SWM facility as-built package within 45 days of completion of construction activities associated with all SWM facilities and practices but not including establishment of the specified landscaping items. The landscaping phase of SWM facilities and practices need not be completed to submit the SWM facility as-built certification package for Structural Acceptance but is required for Final Approval.
2. Resubmit the SWM facility as-built package with responses to all MDE comments that may be received. Resubmit as many times as necessary, updating the SWM facility as-built package as needed to address all MDE comments, and making any field adjustments as needed to correct deficiencies, until MDE approval is obtained.

1.7 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

1.8 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Certifying Engineer Documentation: Submit one copy of the Certifying Engineer's resume to the Owner and Architect that includes following information.
 1. Name of Certifying Engineer.
 2. Maryland professional engineering or professional surveyor license number and expiration date.
 3. Name of employer.
 4. Contact Information.
 5. Relevant work experience.
 6. Proof of valid certification of the Maryland Department of the Environment (MDE) Responsible Personnel for Erosion and Sediment Control training course (formerly "Green Card"). Note: All certifications for the former course MDE Responsible Personnel Training for Erosion and Sediment Control ("Green Card") expired on December 31, 2016 and are no longer valid.
- C. Shop Drawings:
 1. Manholes: Include plans, elevations, sections, details, frames, and covers.
 2. Weirs and Overflow Structures: Include plans, elevations, sections, and details.
 3. Catch basins and stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.
- D. Shop Drawings:
 1. Manholes: Include plans, elevations, sections, details, frames, and covers.
 2. Weirs and Overflow Structures: Include plans, elevations, sections, and details.

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3. Catch basins and stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.

1.9 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, testing agency.
- B. Material and Product Certificates: For each type of material and product used.
- C. Material Test Reports: For each material used, by a qualified testing agency.
- D. Field quality-control reports.

1.10 REFERENCE DOCUMENTS

- A. Maryland Department of the Maryland Approved Stormwater Management and Erosion Control Plans and Permit.
- B. Maryland Department of the Environment General Permit for Stormwater Associated with Construction Related Activities.

1.11 QUALITY CONTROL

- A. Inspection Agency: Contractor shall engage an independent Inspection Agency for complete inspection and testing of soils and compaction.
- B. Notifications: The Contractor is required to notify the Owner and Architect 72 hours prior to the start of construction of Stormwater Management (SWM) Environmental Site Design (ESD) facilities for the purposes of the Maryland Department of the Environment As-Built requirements as indicated on the plans.

PART 2 - PRODUCTS

2.1 STORMWATER MANAGEMNET PRODUCTS AND MATERIALS

- A. As indicated on the Contract Documents and Maryland Department of the Environment Approved Plans.

PART 3 - EXECUTION

3.1 STORMWATER MANAGEMENT CONSTRUCTION

- A. Obtain the services from and designate a Certifying Engineer prior to beginning construction of SWM facilities and practices.

- B. Failure to receive approval for the Certifying Engineer, failure to submit information about the Certifying Engineer designees, or failure of the Certifying Engineer, or the Certifying Engineer designees, to adequately monitor the specified construction activities will be grounds for replacement of the Certifying Engineer and reconstruction of all work on SWM facilities and practices that may have already been performed.
- C. Perform all construction activities on SWM facilities and practices only in the presence of the Certifying Engineer or the Certifying Engineer designee. Failure to perform work in the presence of the Certifying Engineer or the Certifying Engineer designee will be grounds for removal and replacement of the Certifying, and reconstruction of all work that may have already been performed.
- D. Prior to beginning or continuing construction activities of SWM facilities and practices, ensure the Certifying Engineer or the Certifying Engineer designee is present. If the Certifying Engineer or Certifying Engineer designee is not present, suspend work on SWM facilities and practices and do not resume until the Certifying Engineer or Certifying Engineer designee is present for the activities.
- E. Whenever the Certifying Engineer or the Certifying Engineer designee indicates that SWM facilities and practices under construction do not match the Contract Documents, immediately correct the deficiencies before moving to the next construction activity associated with SWM facilities and practices. If it is not possible to correct deficiencies due to the site conditions or constraints and not due to negligence and inadequate quality of work, cease work on SWM facilities and notify the Owner and Architect.
- F. Upon completion of constructing SWM facilities and practices, perform an as-built survey of the completed facility. Complete installation and establishment of landscaping items need not be completed to perform the as-built survey of SWM facilities and practices.
- G. Submit the SWM facility as-built certification package. Update SWM facilities as- built surveys when adjustments are made to address comments that may be received.
- H. No additional compensation will be considered for addressing comments received on the submitted SWM facilities as-built certification package, revisions to the SWM facility as-built certification package, or any construction activities necessary to address comments that may have been received or necessary to revise the SWM facility as-built certification package.

3.2 RESPONSIBILITY OF THE CERTIFYING ENGINEER

- A. Ensure that the Certifying Engineering performs the following:
 - 1. Is present for all activities listed on the SWM as-built certification data tables, performs duties as specified, and records requisite information for the SWM facility as-built certification package. The Certifying Engineer may elect to use a designee as specified in this section. Ensure that the data is available at the Site and on-demand.
 - 2. Prepares written inspection reports for construction activities associated with SWM facilities and practices. The Certifying Engineer may elect to use a designee as specified in this section. The inspection reports must include the following information.

- a. The SWM facility identification number.
 - b. The date and location of the activity.
 - c. Photographs of the activity with narrative descriptions.
 - d. Whether SWM facility construction matches the Contract Documents, noting any deviations from the Contract Documents and how the deviations are addressed. Whenever deviations occur and exceed the specified tolerances, notify the Owner and Architect.
3. Completes the SWM facility as-built certification data tables in the Contract Documents.
 4. Takes photographs during construction activities of the SWM facilities and practices and of the completed SWM facilities, including photographs with completed landscape planting installation and establishment. The Certifying Engineer may elect to use a designee as specified in this section.
 5. Obtains copies of material approvals for items associated with the SWM facilities and practices. The Certifying Engineer may elect to use a designee as specified in this section.
 6. Obtains copies of compaction test results for SWM facility embankments. The Certifying Engineer may elect to use a designee as specified in this section.
 7. Alerts the Contractor when the SWM facilities and practices under construction do not match the Contract Documents and MDE approved Plans. The Certifying Engineer may elect to use a designee as specified in this section.
 8. When necessary, performs all computations that demonstrate SWM facilities and practices function in the manner as presented in the approved Final SWM Report, including with all revisions to the report that may result from Redline Revisions. At a minimum, the parameters examined by the Certifying Engineer shall include but are not limited to storage volumes, discharge rates, velocities, detention times, water surface elevations, freeboard, and all other information as recommended by the Certifying Engineer and as requested by the Owner, Architect or MDE.
 9. Obtains copies of as-built surveys for the SWM facilities and practices.
 10. Prepares the SWM facility as-built certification package.

3.3 STORMWATER MANAGEMENT CONSTRUCTION TOLERANCES

- A. All stormwater management facilities shall be built with the specified tolerances:
 1. Earthwork. Elevations within 3 in. of elevations specified in the Contract Documents.
 2. Embankments, Clay Cores and Cut-off trenches. Elevations not less than the values specified.
 3. Drainage Structures. Elevations within 1.2 inches (0.1 feet) of the values specified.
 4. Pipe Inverts. Elevations with 1.2 inches (0.1 feet) of the values specified.
 5. Riprap. Dimensions within 3 inches of dimensions specified.
 6. Freeboard. Not less than the values specified.
 7. Volumes. Not less than the values specified.
 8. Aggregate, Sand, Bioretention Soil Mix and Mulch Thickness. Not less than the values specified.
- B. When construction tolerances cannot be met due to unforeseen site conditions or constraints, ensure that calculations are performed by the Certifying Engineer before proceeding with the next construction activity associated with SWM facilities and practices. If, after performing computations, the Certifying Engineer determines that the SWM facilities do not meet the

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functional parameters in the approved Final SWM Report as constructed, reconstruct the SWM facilities to meet the functional parameters. If this is not possible due to the site conditions or constraints and not due to negligence and inadequate quality of work, cease work on SWM facilities and notify the Owner and Architect.

- C. The Contractor shall make all necessary adjustments and repairs, at no additional cost to the owner, to bring each facility in compliance with the approved designs.

3.4 STORMWATER MANAGEMENT FACILITY MAINTENANCE

- A. The Contractor shall be solely responsible for maintenance of all stormwater-related facilities until the Maryland Department of the Environment conducts the closeout inspection and releases the permit. The Contractor shall also perform any required maintenance to the facility to ensure full functionality, and any final required punch-list items as required by Owner, prior to final Owner acceptance of the facility.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Prepare test and inspection reports.

3.6 PROTECTION

- A. Protect stormwater management facilities from contamination from sediment.

END OF SECTION 334199

SECTION 334200 - STORMWATER CONVEYANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. PE pipe and fittings.
 - 2. PVC pipe and fittings.
 - 3. Concrete pipe and fittings.
 - 4. Cleanouts.
 - 5. Manholes.
 - 6. Catch basins.
 - 7. Stormwater inlets.
 - 8. Pipe outlets.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Manholes: Include plans, elevations, sections, details, frames, and covers.
 - 2. Catch basins, stormwater inlets and dry wells. Include plans, elevations, sections, details, frames, covers, and grates.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
- B. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes in accordance with manufacturer's written rigging instructions.
- D. Handle catch basins and stormwater inlets in accordance with manufacturer's written rigging instructions.

PART 2 - PRODUCTS

2.1 CORRUGATED-PE PIPE AND FITTINGS

- A. Source Limitations: Obtain corrugated-PE pipe and fittings from single manufacturer.
- B. Corrugated-PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252, Type S, with smooth waterway for coupling joints.
- C. Corrugated-PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294, Type S, with smooth waterway for coupling joints.
- D. Corrugated-PE Silttight Couplings: PE sleeve with ASTM D1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

2.2 PVC PIPE AND FITTINGS

- A. Source Limitations: Obtain PVC pipe and fittings from single manufacturer.
- B. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
- C. PVC Piping:
 - 1. Pipe: ASTM D1785, Schedule 40 and Schedule 80 PVC, with plain ends for solvent-cemented joints.
 - 2. Fittings: ASTM D2466, Schedule 40 and ASTM D2467, Schedule 80 PVC, socket type.
- D. Adhesive Primer: ASTM F656.

2.3 CONCRETE PIPE AND FITTINGS

- A. Source Limitations: Obtain concrete pipe and fittings from single manufacturer.

B. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C76.

1. Bell-and-spigot ends and gasketed joints with ASTM C443, rubber.
2. Class IV, Wall A.

2.4 CLEANOUTS

A. PVC Cleanouts:

1. Source Limitations: Obtain PVC cleanouts from single manufacturer.
2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.5 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: ASTM A615/A615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch- minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.6 CONCRETE

- A. General: Cast-in-place concrete in accordance with ACI 318, ACI 350, and the following:
1. Cement: ASTM C150/C150M, Type II.
 2. Fine Aggregate: ASTM C33/C33M, sand.
 3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 1 percent through manhole.
 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 4 percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

2.7 CATCH BASINS

- A. Standard Precast Concrete Catch Basins:
1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
 3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
 4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 5. Joint Sealant: ASTM C990, bitumen or butyl rubber.

6. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
7. Steps: ASTM A615/A615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches.
8. Pipe Connectors: ASTM C923, resilient, of size required, for each pipe connecting to base section.

B. Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 24 inches minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

C. Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include 24-inch ID by 7- to 9-inch riser with 4-inch- minimum width flange, and 26-inch- diameter flat grate with small square or short-slotted drainage openings.

1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.8 STORMWATER INLETS

- A. Combination Inlets: Made with vertical curb and horizontal gutter opening, of materials and dimensions in accordance with Maryland State Highway Administration. Include heavy-duty frames and grates.
- B. Frames and Grates: Heavy duty, in accordance with utility standards.

2.9 PIPE OUTLETS

- A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.
- B. Riprap Basins: Broken, irregularly sized and shaped, graded stone in accordance with MDE's Erosion and Sediment Control Standards and Specifications.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, nonpressure drainage piping in accordance with the following:
 - 1. Install piping pitched down in direction of flow.
 - 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
 - 3. Install piping with 36 inch- minimum cover.
 - 4. Install PE corrugated sewer piping in accordance with ASTM D2321.
 - 5. Install PVC piping in accordance with ASTM D2321 and ASTM F1668.
 - 6. Install reinforced-concrete sewer piping in accordance with ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping in accordance with the following:
 - 1. Join corrugated-PE piping in accordance with ASTM D3212 for push-on joints.
 - 2. Join PVC piping in accordance with ASTM D2321 for elastomeric-seal joints or ASTM F794 for gasketed joints.
 - 3. Join reinforced-concrete sewer piping in accordance with ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
 - 4. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 - 1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
- B. Set cleanout frames and covers in earth. Set with tops 6 inches above surrounding earth grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants in accordance with ASTM C891.
- C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.6 CATCH BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

3.7 STORMWATER INLET AND OUTLET INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Construct riprap of broken stone, as indicated.
- C. Install outlets that spill onto grade, anchored with concrete, where indicated.
- D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- E. Construct energy dissipaters at outlets, as indicated.

3.8 CONCRETE PLACEMENT

- A. Place cast-in-place concrete in accordance with ACI 318.

3.9 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 221413 "Facility Storm Drainage Piping."
- B. Connect force-main piping to building's storm drainage force mains specified in Section 221413 "Facility Storm Drainage Piping." Terminate piping where indicated.
- C. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
 - a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
 - 4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- D. Connect to sediment interceptors specified in Section 221323 "Sanitary Waste Interceptors."
- E. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
 - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. Unshielded flexible couplings for same or minor difference OD pipes.

- b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
2. Use pressure-type pipe couplings for force-main joints.

3.10 IDENTIFICATION

- A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
 1. Use warning tape or detectable warning tape over ferrous piping.
 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.11 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 1. Submit separate reports for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems in accordance with requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
 5. Gravity-Flow Storm Drainage Piping: Test in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:

Maryland State Police
Tactical Administration Center
PA-745-210-001
100% CD Specifications

- a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping in accordance with ASTM F1417.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.12 CLEANING

- A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

END OF SECTION 334200