

GOUCHER COLLEGE GOLDSMITH INTERFAITH CENTER

Goucher College
1021 Dulaney Valley Rd
Baltimore MD 21204



PROJECT MANUAL

50% CONSTRUCTION DOCUMENT SUBMISSION

APRIL 28, 2017

Architect/Landscape

Ayers Saint Gross
Baltimore, MD

IT/AV/Security

SpeXsys
Hanover, MD

Code

Koffel Associates
Columbia, MD

Geotechnical

Herbst-Benson & Assoc.
Reisterstown, MD

Civil

WBCM
Towson, MD

Structural Engineer

Morabito Consultants
Sparks, MD

MEP/FP Engineer

Mueller
Baltimore, MD

Commissioning

Kibart
Towson, MD

DOCUMENT 00 0010

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END OF DOCUMENT

DOCUMENT 00 3132

GEOTECHNICAL DATA

1.1 GEOTECHNICAL DATA

- A. This Document and its referenced attachments are for information and are not part of the Contract Documents.
- B. A final geotechnical investigation report, prepared by Herbst/Benson, dated January 5, 2017, is appended to this Document.

END OF DOCUMENT

HAEBLER CHAPEL INTERFAITH ADDITION
GOUCHER COLLEGE
BALTIMORE COUNTY, MARYLAND

HERBST/BENSON & ASSOCIATES
GEOTECHNICAL ENGINEERS

January 5, 2017

Ayers Saint Gross
140 Hull Street
Suite 100
Baltimore, Maryland 21230

Attention: Ms. Alice Brooks

Re: Haebler Chapel Interfaith Addition
Goucher College
Baltimore County, Maryland

Dear Ms. Brooks:

In accordance with your authorization we have completed a geotechnical investigation for the above-referenced project which will consist of a building addition of the northwest side of the existing chapel. The original scope of the project was to provide a preliminary geotechnical look at the site to determine the general suitability of the site for the intended development; possible subsurface factors in locating the building vertically and horizontally, such as groundwater or rock; the possible foundation types and capacities; and the expected earthwork construction and capabilities of soils for grade slab support. We were later directed to provide a more detailed analysis, because there would be no additional final design study for earthwork and foundation analysis. The methods of explorations and tests, the subsurface data, the laboratory test results, and our conclusions and recommendations concerning the geotechnical aspects of the proposed structure are presented in the following sections of the report.

I. SUBSURFACE PROGRAM

The subsurface exploratory program consisted of three standard penetration test borings; B-1 through B-3 in the proposed building addition area. The approximate locations of the test borings have been shown on PLATE 1, BORING LOCATION PLAN. An ATV-mounted drilling rig using hollow stem, continuous flight helical augers advanced the test borings to the planned termination depths of 25 feet. Standard penetration testing and split spoon soil sampling were performed at regular intervals as the borings were advanced. A bulk soil sample was obtained from the upper portions of borings B-2 and B-3.

The information obtained from the test borings is presented on PLATE 2, BORING PROFILES. The method of classification used for the soil descriptions shown on the boring profiles is outlined on the enclosure CLASSIFICATION OF SOILS included in the back of this report.

II. LABORATORY TESTING

The two bulk soil samples were subjected to existing moisture and moisture / compacted density relationship testing to evaluate compaction properties, and to sieve gradation and Atterberg limits testing to determine suitability for grade slab support when properly compacted. An upper split-spoon soil sample from boring B-1 was also subjected to sieve gradation and Atterberg limits testing to determine laboratory soil classifications. Natural moisture content testing was performed on the upper recovered split spoon samples from each boring. The results of these tests are presented as follows:

TABLE 1, CLASSIFICATION TEST DATA
SHEETS 1 and 2, COMPACTION TEST
PLATE 2, BORING PROFILES
(Moisture contents shown on left side of boring column
at appropriate sample depth)

III. SITE DESCRIPTION

The study area is northwest of and contiguous to the existing Haebler Chapel on the Goucher College Campus. The area of the proposed addition is presently a lawn with trees at the northern end. The ground slopes downward from about elevation 433 near the chapel to elevation 424 at the north corner of the addition site. More details concerning existing site conditions can be found the boring location plan.

IV. SUBSURFACE MATERIALS

A surface layer of topsoil about 4 inches thick is present at all boring locations. Beneath the topsoil, existing fill was found in borings B-1 and B-2. The 8 feet of existing fill in B-1 are very stiff sandy clay & silt with a trace of miscellaneous material as noted by a small piece of burned wood recovered during sampling. The standard penetration resistances are quite consistent. The 3 feet of fill in B-2 are dense clayey silty sand again with small trace pieces of miscellaneous materials. The fill soil types and apparent uniform consistency within each of the two borings indicates that some care was taken during fill placement and compaction, although we doubt that any documentation of fill construction is available.

The upper 3- to 4-foot thick layer of native soil in all three borings is very stiff, moderate plasticity clay & silt with variable quantities of sand. The underlying soils in the boring depths are medium dense sand and silt combinations.

V. GROUNDWATER

Groundwater was not encountered in any of the test borings above borehole cave-in depths and was not evident by seepage or wet soil conditions during, at completion of, or one day after completion of the drilling operations.

The groundwater observations represent conditions at the time of the test boring program. Groundwater levels will tend to vary with changes in seasons and precipitation, typically rising through the late winter, spring and early summer season and receding through the remainder of the year under normal precipitation patterns.

VI. PROPOSED CONSTRUCTION

From information provided by the structural engineer, it is our understanding that the addition will be a 2-story, steel framed structure with lightly loaded "store front" exterior walls. The lower level in the south section of the building will match existing chapel grade slab at elevation 334. The north end of the addition will be underlain by a 12-foot high mechanical basement with slab elevation 322.

The second floor of the south section will be column supported with column loads up to 25 kips. The exterior wall loads with storefront construction are expected to be minimal. A short length of the south section ground floor wall will be masonry and stone with an estimated load of 5 kips per foot of wall length. The north section of the addition will be supported on exterior masonry block / quarry stone walls and two larger interior columns. Wall loads are estimated at 9 kips per foot of wall length with the column loads up to 70 kips.

Grading will be required within the building footprint. The proposed grades on the south section will be near existing grade at the chapel, but with the existing grade dropping away from the chapel, with up to 3 feet of fill will needed at the interior basement wall. The basement section will require cuts up to 8 feet deep. The deepest cuts and fills within the addition will be adjacent to the interior basement wall.

VII. BUILDING SUPPORT RECOMMENDATIONS

The presence of existing fill presents several options for support of the south building section. We do not know the history of the fill...was it placed merely to even grades around Haebler or was it placed in lifts and purposefully compacted during the construction of Haebler in hopes of a future building addition? If so, what was the planned configuration of the addition?

These questions indicate the difficulty in considering existing fill in building support. Although the existing fill in the borings is composed of relatively clean soil and is quite uniform in apparent density, medium dense to dense, there is no degree of certainty concerning the continuity of these conditions; thus, the use of the existing fill for various levels of building support must be carefully considered.

A. Footings

Basement (North Section)

Considering the proposed construction in conjunction with the subsurface materials, we recommend that the section of the addition including the basement be supported on shallow footings at or near normal plan grade in competent native soils and proportioned for a maximum allowable soil bearing pressure of 3,000 PSF. At the maximum pressure we estimate total settlement to be no greater than 0.75 inches and differential settlement no greater than 0.5 inches.

No Basement (South Section)

Several options are available for foundation support in this portion of the building.

1. Removal and Replacement of Existing Fill

With this option all existing fill would be removed from the south section of the addition, except for the connecting bridge to the main building, and replaced with properly controlled compacted fill as outlined in the EARTHWORK section of this report. Footings could then be constructed at plan grade and proportioned for an allowable soil bearing pressure up to 3,000 PSF. The connecting bridge columns would need to be extended into original ground.

An advantage to this option would be that foundations, except for the connecting bridge, could be supported at normal grade. A disadvantage would be the time and expense of the earthwork operation.

2. Trenching Along Footing Lines

In a series of trenches and pits centered on the footings, excavate each footing extending 2 feet beyond the edges of the footing down to approved original ground and backfill with approved material in accordance with APPENDIX I, COMPACTED FILL up to plan footing grade. For closely spaced column footings, a trench excavation to the stated dimensions which would include several column footings may be more efficient. With this option, footings can be supported at normal plan grades and proportioned for an allowable soil bearing pressure of 3,000 PSF.

The advantage to this option is acceptable footing support at normal plan grade. A disadvantage would be the time and effort to undercut and backfill small areas, using in some instances walk-behind rollers and jumping jack tampers for fill compaction. Also, with the number and arrangement of column footings, it may be more cost effective and efficient to use Option 1 above.

3. Footing Support to Original Ground

In this option, footing excavations would be extended down into original ground beneath the fill to obtain an allowable soil bearing pressure of 3,000 PSF at least 8 inches into the original ground. Proper foundation support can be provided either by lowering the plan footing to the approved founding grade in native soil and extending the height of the foundation pier, or, by backfilling the undercut depth with minimum 500 psi flowable fill or lean concrete to plan bottom-of-footing elevation.

An advantage would be limited remedial earthwork. A disadvantage would be the quantity and cost of flowable fill or lean concrete backfill.

4. Footing Support in Existing Fill

Footings would be founded at or near plan depth in existing fill and proportioned for a maximum allowable bearing pressure of 1,500 PSF. This would be the least positive of the options because of potential variability in fill type and consistency. If this option is to be considered, additional test borings would be needed before construction to determine if the option is possible and DCP testing of each footing excavation during construction.

General Footing Recommendations

For continuity of support over minor variations in soil supporting quality, we recommend wall footings be reinforced with at least two #5 steel reinforcing bars. The structural engineer may require additional reinforcement. Footing dimensions should meet structural and building code requirements; thus, the actual applied pressures may be less than the 3,000 PSF recommended maximum design pressures.

All footings should be founded at least to the minimum depth as per local code for protection from detrimental frost action. All new wall footings should tie into the existing basement wall footings and step up to meet normal grade. No footings should be founded above a 1:1 line drawn up and away from the bottom outer edge of the interior basement wall footing to prevent placing additional lateral load on the existing basement wall.

Foundation concrete should be placed the same day foundations are excavated, reinforced and approved. Leaving excavations open for an extended period can result in softening, loosening or saturation of the founding soils requiring that the bottom of the footing excavations be scraped of any soft or loose material to again expose an undisturbed founding surface of sufficient strength immediately prior to concrete placement.

B. Grade Slabs

With building pad preparation as outlined in the EARTHWORK section of this report, slabs may be supported on approved existing fills, newly placed fills over approved existing fills, or original ground. Slabs should be proportioned for a modulus of subgrade reaction no greater than 100 psi/in. Slabs should be underlain by an open-graded aggregate base and polyethylene vapor barrier to limit transpiration of soil moisture through the slab section and thus minimize building dampness following construction.

C. Lateral Earth Pressure

There will be several instances where building walls will retain significant depths of fill. The proposed upper cut soils are low to moderate plasticity, predominantly fine-grained sandy clays and silts. In our opinion, these soils are not well suited for basement wall backfill. They are difficult to evenly compact; they have low permeability and can trap water against the wall; and they can exert high lateral earth pressures. Low plasticity granular soils, or low plasticity silt or clayey silt soil with a high percentage of sand component should be used for wall backfill in the critical soil wedge behind the wall. Information concerning the extent of the critical wedge, the recommended backfill soil types, and compaction criteria, as well as general recommendations concerning waterproofing and drainage are presented on PLATE WD, WALL DRAIN AND BACKFILL DETAILS. For these soil types, we recommend the following earthwork design parameters.

Total Unit Weight:	130 PCF
Friction Angle:	30°
Cohesion:	0

Coefficient of Friction: (Footing concrete against competent native silty sand or sandy silt soils)	0.40
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*Active Earth Pressure: (Unrestricted rotation at top of wall)	43 PSF/ft.
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*At Rest Earth Pressure: (Restricted rotation at top of wall)	65 PSF/ft.
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*These values assume no buildup of hydrostatic pressure behind the wall, and a level surface on the high side of the wall. A surcharge should be added as needed to reflect the use of the area behind the high side of the wall. Up-sloping ground behind the wall will increase the applied pressure from those noted above. All the above values are unfactored.

D. Seismic Site Classification

Given that the founding soils are residual, it has been our experience in this area that within 100 feet of the surface, the subsurface profile will extend into hard bedrock. We recommend an IBC 'C' seismic site soil classification for this project.

VIII. EARTHWORK CONSIDERATIONS

All fill placed for building support shall be controlled and compacted in accordance with APPENDIX I, COMPACTED FILL. The following procedure is recommended for building pad preparation.

1. Remove all vegetation, topsoil, existing construction and other miscellaneous materials from the proposed building pad area. For Option 1, the building pad area will be defined as the building footprint plus a lateral extension of one foot beyond the exterior footing edges for every foot depth of undercut plus planned fill. For Option 2 through 4, the building pad would extend at least 5 feet beyond the exterior wall line to expose competent native soils or clean existing soil fill. Proofroll the exposed surface with a loaded tandem dump truck to delineate any soft yielding areas.
2. For Option 1, further undercut all existing fill to expose competent native soil within the building pad dimensions noted in Step 1 above. For Options 2 through 4, only undercut any soft yielding areas or otherwise unsuitable soils to expose a firm surface in competent native soils or clean existing fills.
3. Additionally, relocate all existing utilities outside the building addition area. Utilities which cannot be relocated should have trench fill removed to expose the top of the pipe, the pipe examined, repaired or replaced as necessary and backfilled as noted below. Utility trench backfill in the building area should be placed and compacted in accordance with APPENDIX I.
4. Immediately after achieving an approved surface, place controlled compacted fill to subgrade elevation in accordance with APPENDIX I.
5. Recompect the subgrade to a firm unyielding condition and to at least 95% of the AASHTO T-99 maximum dry density immediately before placing the crushed stone slab base.

IX. EXCAVATION CHARACTERISTICS

Soil excavation techniques are expected to be suitable for this project based upon the fact that no dense disintegrated rock or hard rock was found in the test borings. Groundwater is not expected to be a factor in design or construction of the building at the planned grades.

X. CONSTRUCTION MONITORING

Herbst/Benson & Associates shall provide the geotechnical monitoring and testing services during the site grading and foundation construction phases of the work. This is to observe compliance with design concepts, specifications or recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction.

Any soils proposed for fill on the site shall be subjected to laboratory testing and approval prior to being brought to the site. The earthwork construction including stripping, undercutting, proofrolling and controlled fill placement shall be observed with in-place density tests taken to verify construction according to the specifications.

All open footings shall be thoroughly examined, tested by penetrometer, and the exposed soil conditions approved for the design bearing prior to placing reinforcement and concrete. This is particularly important if footings are proposed for support in existing fill at plan grade. We can provide the indicated geotechnical monitoring and testing services upon request.

XI. ADDITIONAL RECOMMENDED SERVICES

If supporting footings on existing fill is perceived as a potential viable option, additional explorations will be required. We would recommend at least three additional SPT borings with continuous sampling through the fill supplemented with laboratory natural moisture content determination and moisture / compacted density relationship testing.

XII. GENERAL CONDITIONS

This report has been prepared in accordance with generally accepted geotechnical engineering practice to aid in the evaluation and design of this project. In the event of changes or refinements to the proposed construction (types, elevations, locations, etc.), the conclusions and recommendations presented in this report should not be considered valid unless changes are reviewed and the conclusions of this report are modified or approved in writing by our office.

The analyses and recommendations included in this report are based upon the data obtained from the test borings performed at the approximate locations indicated on the boring location plan. This report does not reflect variations which may occur between or away from the borings. The nature and extent of the variations may not become evident until the time of construction. If significant variations then become evident, it may be necessary for us to reevaluate the recommendations of this report.

We appreciate the opportunity to provide a geotechnical investigation and evaluation of the proposed building addition to Haebler Chapel. We will be available to provide additional consultation during the design period and hope to have the opportunity to follow the project through construction by providing geotechnical monitoring and testing services and concrete testing. Please do not hesitate to contact us should you, your client, or the other consultants have any comments or questions.

Most Sincerely,

HERBST/BENSON & ASSOCIATES

By: Robert C. Benson, P.E.
Principal

RCB/flh
16081MD

APPENDIX I **COMPACTED FILL**

A. Embankment shall be constructed of approved materials from the excavation or from other sources. The material shall be free from organic materials, trash, muck, roots, frost and other deleterious substances.

B. Before depositing fills, the ground surface shall be cleared of all refuse, brush, grass, roots, ice and frozen material. All organic matter and otherwise unsuitable soils shall be removed from the surface to be filled. The exposed surface shall be plowed or scarified if required to a depth of six inches. Soils so scarified, or which have been disturbed by grubbing and stripping operations, shall be compacted to undisturbed soil below by discing, leveling, rolling, and compacting at the moisture content and to the density specified below for compacted embankments.

C. Where fills are made on hillsides or slopes, the slope of the original ground upon which the fill is to be placed shall be plowed or scarified deeply, or where the slope ratio of the original ground is steeper than 5 horizontal to 1 vertical, the bank shall be stepped or benched, when considered necessary by the Engineer, to permit placement of the fill in horizontal layers.

D. Placing, Spreading and Compacting Fill Materials:

1. The fill materials shall be placed in layers which, before compaction shall not exceed 8 inches with the exception of clay soils which shall be placed and compacted in maximum 6-inch thick loose lifts. Each layer shall be spread uniformly and evenly and shall be thoroughly blade mixed during the spreading to insure uniformity of materials in each layer and individual rock pieces or soil clumps no greater than half the loose lift thickness.

2. After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted to not less than 95% of the maximum dry density as determined by ASTM D 698.

3. The moisture content of the fill shall be as required in order to attain the degree of compaction specified.

4. Compaction shall be by approved multiple-wheel pneumatic tired rollers, vibratory rollers or other types of acceptable rollers.

5. The filling operation shall be continued as specified above until the fill has been brought to the subgrade shown on the plans.

6. The fill shall be constructed in such a manner that the surface will be sloped to drain at all times, and all fill shall be deposited to prevent excessive moisture accumulation from rainwater.

7. When the work is interrupted by rain, filling shall not be resumed until tests indicate that the moisture content and density of the top 6 inches of fill conform to the above specification requirements.

HAEBLER CHAPEL INTERFAITH ADDITION
 GOUCHER COLLEGE
 BALTIMORE COUNTY, MARYLAND
 16081MD

JANUARY 2017

TABLE 1

CLASSIFICATION TEST DATA

<u>Sieve/Particle Size</u>	<u>% by Weight Passing Indicated Size</u>		
	<u>B-1</u> <u>(3.5'-5.0')</u>	<u>B-2</u> <u>(4.0'-8.0')</u>	<u>B-3</u> <u>(3.0'-6.0')</u>
3/4"	100		100
1/2"	95	100	98
3/8"	94	98	92
#4	84	97	77
#10	78	95	64
#40	65	88	45
#60	61	82	39
#200	52	55	31
<u>Atterberg Limits</u>			
Liquid Limit (LL)	42	35	30
Plasticity Index (PI)	20	10	12
<u>Classification</u>			
Unified	CL	ML	SC
AASHTO	A-7-6(7)	A-4(4)	A-2-6(0)
<u>Natural Moisture Content (%)</u>	15.8	13.5	7.8

COMPACTION TEST

PROJECT = Haebler Chapel Addition Goucher College

SAMPLE IDENTIFICATION = B-2 (4.0'-8.0')

CURVE NUMBER = 1, 16081MD DATE = 1/17

MAXIMUM DRY DENSITY (PCF) = 112.4

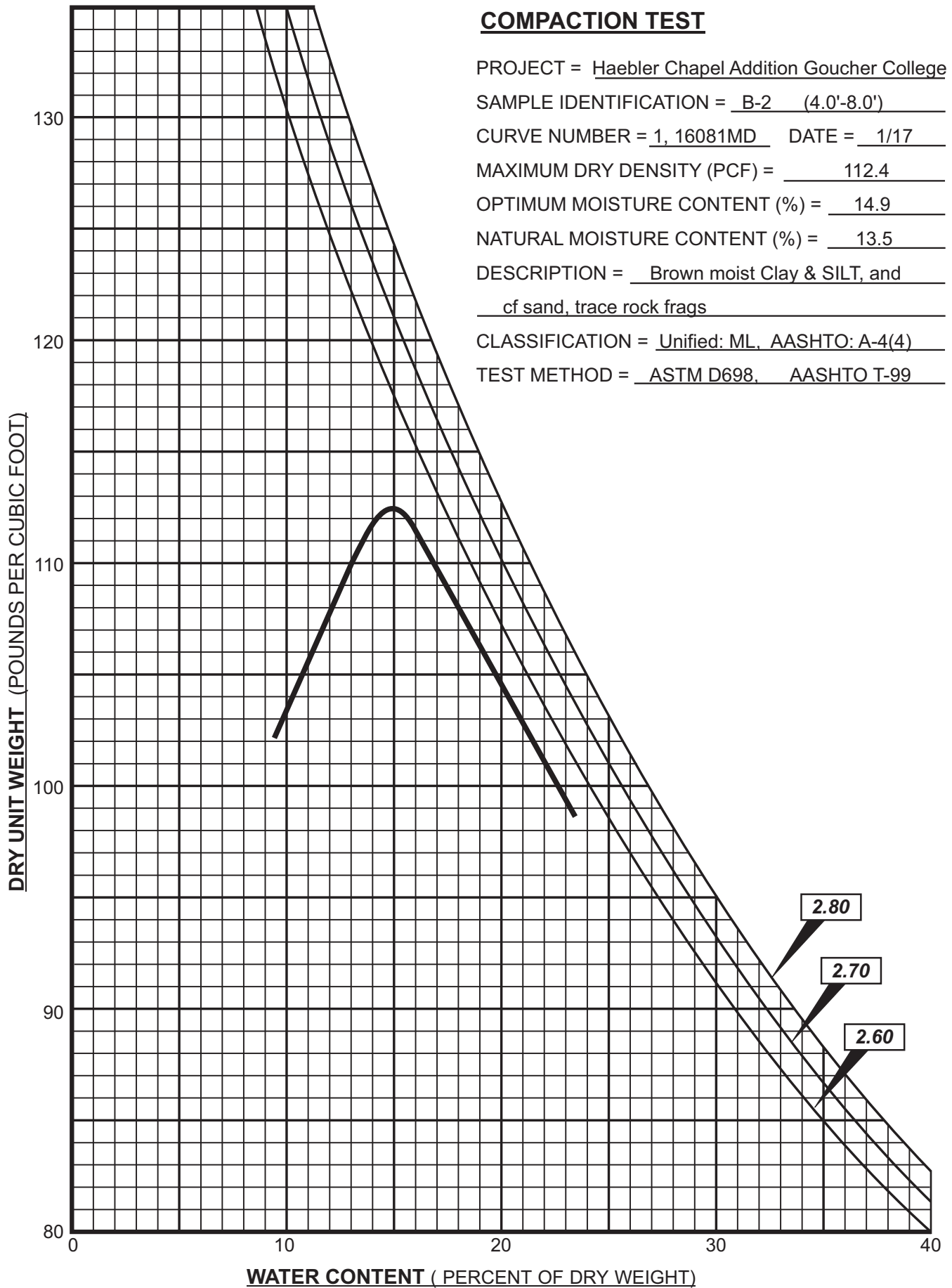
OPTIMUM MOISTURE CONTENT (%) = 14.9

NATURAL MOISTURE CONTENT (%) = 13.5

DESCRIPTION = Brown moist Clay & SILT, and
cf sand, trace rock frags

CLASSIFICATION = Unified: ML, AASHTO: A-4(4)

TEST METHOD = ASTM D698, AASHTO T-99



COMPACTION TEST

PROJECT = Haebler Chapel Addition Goucher College

SAMPLE IDENTIFICATION = B-3 (3.0'-6.0')

CURVE NUMBER = 2, 16081MD DATE = 1/17

MAXIMUM DRY DENSITY (PCF) = 127.8

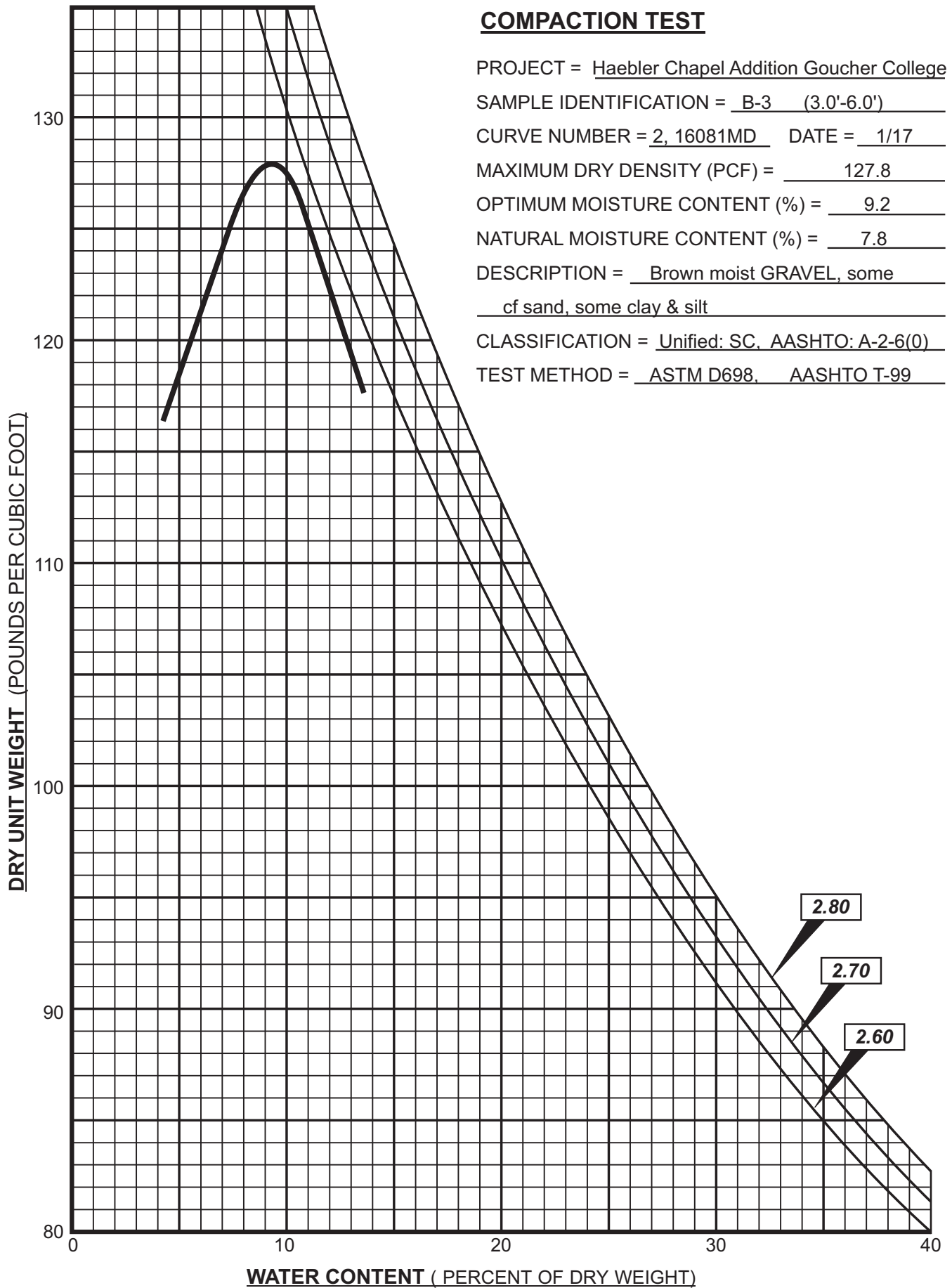
OPTIMUM MOISTURE CONTENT (%) = 9.2

NATURAL MOISTURE CONTENT (%) = 7.8

DESCRIPTION = Brown moist GRAVEL, some
cf sand, some clay & silt

CLASSIFICATION = Unified: SC, AASHTO: A-2-6(0)

TEST METHOD = ASTM D698, AASHTO T-99



CLASSIFICATION OF SOILS

The soil descriptions on the boring profiles are in accordance with the criteria outlined below. The principal constituents are written in capital letters with other constituents preceded by descriptive terminology used to denote the percentages by weight of each component. The soil descriptions are based upon visual examinations except where laboratory gradation and Atterberg limits tests are available.

Descriptive Terms Denoting Component Proportions

Descriptive Terms	Range of Proportion
Trace	1 - 10%
Little	10 - 20%
Some	20 - 35%
And	35 - 50%

Component Definitions by Gradation

Soil Component		Sieve Limits	
		Upper	Lower
*GRAVEL/ ROCK FRAGS	Coarse	3 in.	1 in.
	Medium	1 in.	3/8 in.
	Fine	3/8 in.	No. 10 (2.0mm)
SAND	Coarse	No. 10 (2.0mm)	No. 30 (0.590mm)
	Medium	No. 30 (0.590mm)	No. 60 (0.250mm)
	Fine	No. 60 (0.250mm)	No. 200(0.074mm)
SILT, CLAY and COLLOIDS: (fines defined by degree of plasticity)		No. 200 (0.074mm)	

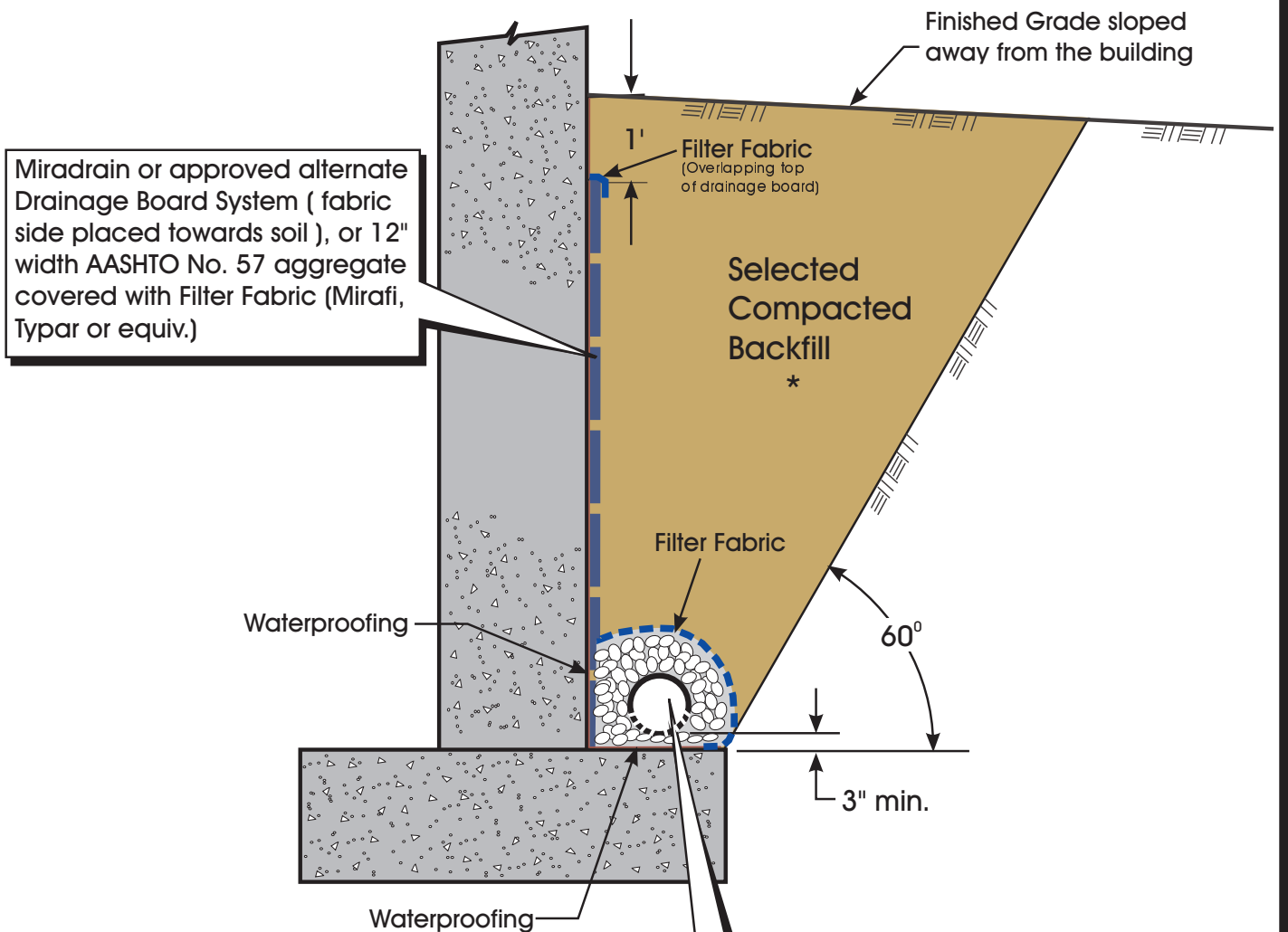
*This component is classified as "GRAVEL" in sedimentary soils and as "ROCK FRAGS" in residual soils.

Component Definitions by Degree of Plasticity

Descriptive Term	Degree of Plasticity	Plasticity Index Range
SILT	None	Non-plastic (NP)
Clayey SILT	Slight	1 - 5
SILT & CLAY	Low	5 - 10
CLAY & SILT	Medium	10 - 20
Silty CLAY	High	20 - 40
CLAY	Very High	Over 40

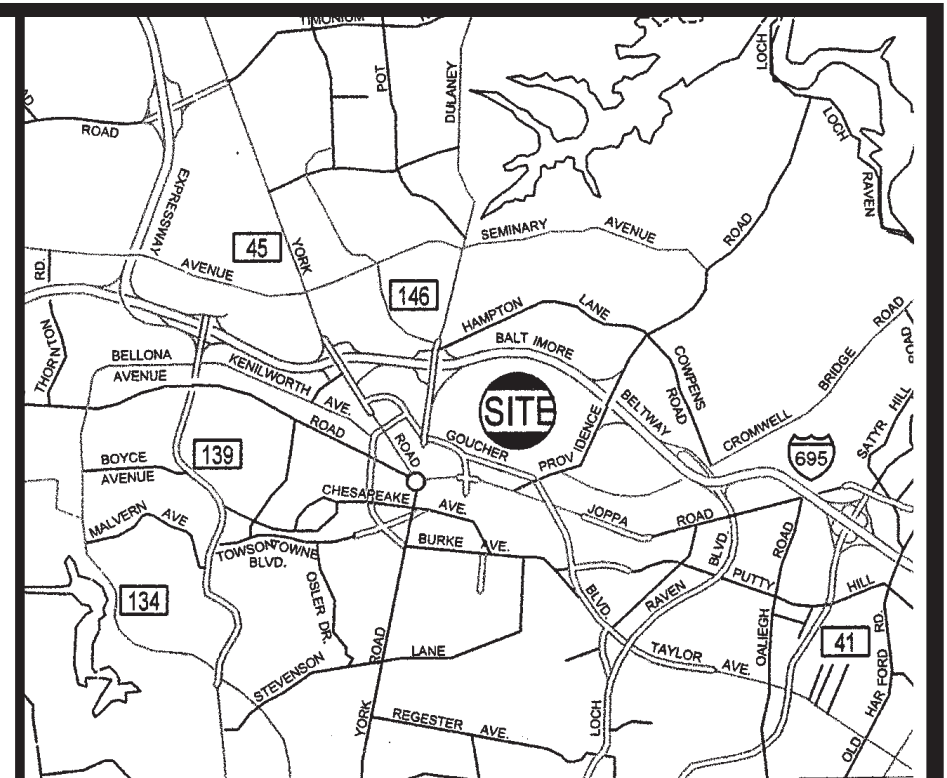
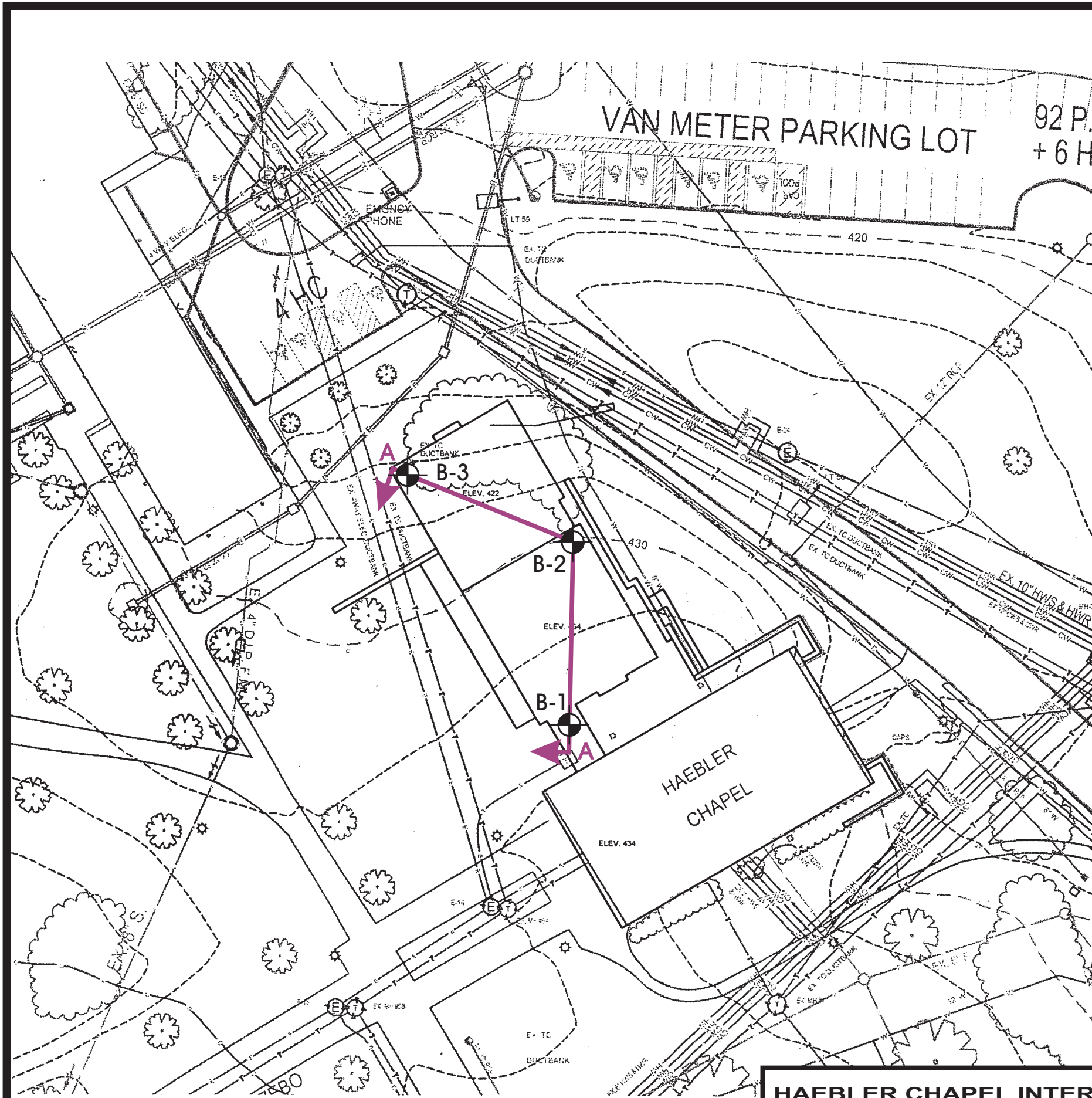
Gradation Terms of Granular Components

Gradation Designation	Symbol	Defining Proportions
coarse to fine	cf	All fractions greater than 10% of the component
coarse to medium	cm	Less than 10% fine
medium to fine	mf	Less than 10% coarse
coarse	c	Less than 10% medium and fine
medium	m	Less than 10% coarse and fine
fine	f	Less than 10% coarse and medium



6" dia. Perf. PVC, Corr. Metal or Equiv. pipe surrounded by min. 3" AASHTO No. 57 aggregate on 0.5% min. slope, gravity outletted to drain. For site retaining walls, weep holes may be used as gravity outlet in place of perf. pipe system.

* Wall backfill to be clean soil conforming to Unified (GW, GP, GM, SW, SP, or SM) Classification. Soil with SC or ML classification with PI < 10 and < 65% p #200 sieve also acceptable subject to laboratory testing. The soil shall be placed and compacted in accordance with APPENDIX 1, COMPACTED FILL.



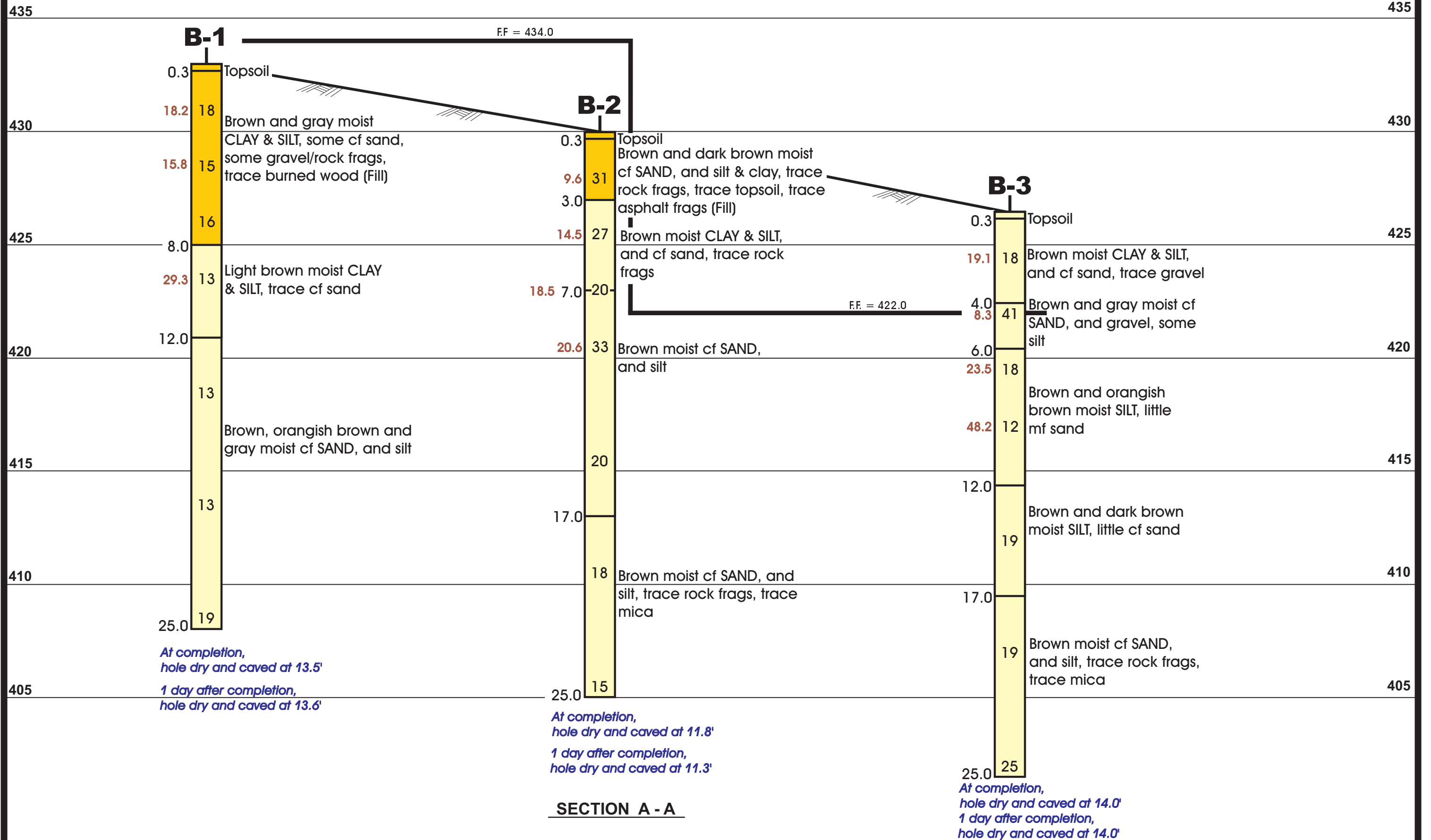
VICINITY MAP

NOTES:

1. Borings B-1 through B-3 performed at the direction of the Geotechnical Engineer during December 2016.
2. Boring locations selected and staked in the field by the Geotechnical Engineer. Locations and elevations shown are approximate.
3. Boring Location Plan and elevations taken from an untitled plan portion provided by the client.
4. Figures in columns on boring profiles represent the standard penetration resistance (N) in blows per foot as determined by the ASTM D1586 procedure using a 2" O.D. - 1 3/8" I.D. sampler.
5. Stratification on boring profiles estimated from driller's observations and recovered soil samples. Actual strata changes may vary from those shown and may be either abrupt or gradual.

**HAEBLER CHAPEL INTERFAITH ADDITION
GOUCHER COLLEGE
BALTIMORE COUNTY, MARYLAND**

BORING LOCATION PLAN		PLATE
HORIZ SCALE (FEET)	0 40	16081MD JAN., 2017
		1



SECTION A - A

HAEBLER CHAPEL INTERFAITH ADDITION GOUCHER COLLEGE BALTIMORE COUNTY, MARYLAND	16081MD	BORING PROFILES		PLATE
	JAN., 2017	HORIZ SCALE 0 _____ 15 (FEET)	VERT SCALE 0 _____ 4 (FEET)	2

x.x = % Moisture

SECTION 01 1000

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. Work by Owner.
 - 4. Owner-furnished products.
 - 5. Access to site.
 - 6. Work restrictions.
 - 7. Specification and Drawing conventions.
- B. Related Requirements:
 - 1. Section 01 5000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 PROJECT INFORMATION

- A. Project Identification: Goldsmith Interfaith Center
- B. Owner: Goucher College.
- C. Architect: Ayers Saint Gross Architects + Planners.
- D. Construction Manager: CAM Construction
- E. Construction Manager: CAM Construction.
 - 1. Construction Manager for this Project is Project's constructor. The terms "Construction Manager" and "Contractor" are synonymous.
- F. Web-Based Project Software: Project software administered by Construction Manager will be used for purposes of managing communication and documents during the construction stage.
 - 1. See Section 01 3100 "Project Management and Coordination." for requirements for establishing administering and using web-based Project software.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The project at Goucher College in Towson, MD consists of minimal renovation of an existing Chapel and the construction of a new Interfaith Center. Goucher College would like to renovate the existing 2 story Haebler Memorial Chapel to be more of an inclusive multi-faith space. The pews, pulpits and iconography will be removed. Foot washing and accessible toilets will be included at the entry level. Additionally, Goucher needs space for the Hillel program, and a new

Multi-Faith Program. The new Center will house offices, a living room and residential kitchen, prayer rooms and lounge space.

- B. The renovation will consist of:
 - 1. The Chapel will be reconfigured to be non-denominational with the addition new plumbing fixtures, lighting and furniture
- C. The new program will consist of:
 - 1. Lower floor: New building support and Mechanical
 - 2. Entry Floor: New lobby and entrance, offices, Great Room, Kitchen, Dining and circulation
 - 3. First Floor: Prayer rooms, Lounge spaces and circulation
- D. The site for the Interfaith Center is the adjacent lawn to the north of the Haebler Memorial Chapel.. The existing building is assumed to be a primary A-2 Use with an existing construction classification of Heavy Timber (HT). The new construction will be a mix of assembly and business occupancies and will be a Type V-B Construction Classification
- E. The project will be completed in (1) phase.
- F. Type of Contract: Project will be constructed under a single prime contract.
- G. Sustainability Goals: The Project is designed to meet LEED NC 2009 Silver Certification standards

1.5 WORK BY OWNER

- A. General: 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. Preceding Work: Owner will perform the following construction operations at Project site. Those operations are scheduled to be substantially complete before work under this Contract begins.
 - 1. The Owner will be responsible for scheduling, coordinating and implementing the building moves before demolition

1.6 OWNER-FURNISHED PRODUCTS

- A. Owner will furnish products indicated. The Work includes receiving, unloading, handling, storing, protecting, and installing Owner-furnished products.
- B. Owner-Furnished Products:
 - 1. The Owner will be responsible for purchasing FFE

1.7 ACCESS TO SITE

- A. General: 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. 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 Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.
- D. 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.

1.8 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 1. Comply with limitations on use of public streets and with 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 providing 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, and Odors: Coordinate operations that may result in high levels of noise and vibration, 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. Restricted Substances: Use of tobacco products and other controlled substances on campus is not permitted.
- F. 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.

1.9 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. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

- C. 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 published as part of the U.S. National CAD Standard and scheduled on Drawings.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 2300

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 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 alternate 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. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated revisions to alternates.
- C. Execute accepted alternates under the same conditions as other work of the Contract.
- D. Schedule: A schedule of alternates is included in the Drawing Set. 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

No	Description	Reference
1	Bluestone paving in lieu of seeded lawn on the north side of the building	L1.00

SECTION 01 2500

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. 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 and proposed by Contractor.
 - 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 in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify 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 facsimile of form provided in Project Manual.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
 - b. Coordination 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 substitution 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 and 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 substitution 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 through Construction Manager 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 achieving LEED prerequisites and credits.

- 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 achieving LEED prerequisites and credits.
 - 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

REQUEST FOR SUBSTITUTION FORM

1. Date: _____ Request No: _____
2. Project Name: Goldsmith Interfaith Center, Goucher College
3. Specification Reference: _____
4. Description of specified product or system: _____
5. Trade name, model number, and name of proposed substitution:

6. What effect does substitution have on applicable code requirements?

7. Differences between proposed substitution and specified item? *(Use attachment for additional space, if required.)*

8. Manufacturer's warranty on proposed and specified items are:
Same Different
(Explain on attachment.)
9. Reason for requesting substitution:
Cause Convenience

10. Monetary considerations:
Specified Product \$ _____
Proposed Substitution: \$ _____
11. Will the Undersigned pay for changes to the building design, including engineering and detailing costs, caused by the requested substitution? Yes No

12. Enclosed data consists of:

Catalog Drawings Samples Tests Reports

13. List availability of maintenance service and replacement materials.

14. State effects of substitution on construction schedule and changes required in other work or product:

15. State effects of substitution on project sustainability goals:

16. Any license fees or royalties: Yes No

UNDERSIGNED certifies:

- \$ Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- \$ Same warranty will be furnished for proposed substitution as for specified product.
- \$ Same maintenance service and source of replacement parts as applicable is available.
- \$ Proposed Substitution will not affect or delay Progress Schedule.
- \$ Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived by the Contractor.
- \$ Proposed substitution does not affect dimensions or functional clearances.
- \$ Payment will be made for changes to building design, including architectural or engineering design, detailing, and construction costs caused by proposed substitution.
- \$ Coordination, installation, and changes to the Work as necessary for accepted substitution will be complete in all respects.

Submitted by:

Signature _____

Firm _____

Address _____

Date _____

Telephone _____

For use by Architect:

Accepted: Accepted As Noted:

Not Accepted: Received Too Late:

Date _____

Remarks: _____

Approved by (C.M.)

By: _____

END OF FORM

SECTION 01 2600

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.

1.3 MINOR CHANGES IN THE WORK

- A. Architect will issue through Construction Manager supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710 or form acceptable to the owner and Architect.

1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Construction Manager 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 Construction Manager 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 Construction Manager.
 - 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 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Change Proposal Request, Construction Manager will issue a Change Order for signatures of Owner and Contractor on AIA Document G701CMA or form acceptable to the owner and Architect.

1.6 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.
 - 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

SECTION 01 3100

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. Requests for Information (RFIs).
 - 4. Project Web site.
 - 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 from Owner, Construction Manager, 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, and telephone number 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 and telephone numbers, including home, office, and 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, in web-based Project software directory, 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 and scheduled activities of other contractors 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.

D. Conservation: Coordinate construction activities to ensure that operations are carried out 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. See other Sections for disposition of salvaged materials that are designated as Owner's property.

1.6 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown 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 the coordination drawings by multiple contractors 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 the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate 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 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, switch board, 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 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 changes as directed and resubmit.
 10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 2. File Preparation Format: DWG, Version , operating in Microsoft Windows operating system.
 3. File Submittal Format: Submit or post coordination drawing files using Portable Data File (PDF) format.
 4. BIM File Incorporation: Construction Manager will incorporate Contractor's coordination drawing files into Building Information Model established for Project.
 - a. Construction Manager will 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.
 5. 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. Contractor shall execute a data licensing agreement in the form of AIA Document C106 or an Agreement form acceptable to Owner and Architect.

1.7 REQUESTS FOR INFORMATION (RFIs)

- 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 RFIs submitted to Architect by other entities controlled by Contractor with no response.
 2. Coordinate and submit RFIs in a prompt manner so as 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. Project number.
 3. Date.
 4. Name of Contractor.
 5. Name of Architect and Construction Manager.
 6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing number and detail references, as appropriate.
 10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 12. Contractor's signature.
 13. 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 and Construction Manager's Action: Architect and Construction Manager will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by Architect or Construction Manager 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 or Construction Manager 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 and Construction Manager in writing within 10 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 and Construction Manager.
 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 and Construction Manager's response was received.

8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

- F. On receipt of Architect's and Construction Manager's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect and Construction Manager within seven 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. Contractor shall execute a data licensing agreement in the form of AIA Document C106 Digital Data Licensing Agreement or an Agreement form acceptable to Owner and Architect.
 4. 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 or an Agreement form acceptable to Owner and Architect.
 5. The following digital data files will be furnished for each appropriate discipline:
 - a. Floor plans.
 - b. Reflected ceiling plans.
 - c. .
- B. Web-Based Project Software: Provide, administer, and use web-based Project software site for purposes of hosting and managing Project communication and documentation until Final Completion.
 1. Web-based Project software site includes, at a minimum, the following features:
 - a. Compilation of Project data, including Contractor, subcontractors, Architect, architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
 - b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
 - c. Document workflow planning, allowing customization of workflow between project entities.
 - d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
 - e. Track status of each Project communication in real time, and log time and date when responses are provided.
 - f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
 - g. Processing and tracking of payment applications.
 - h. Processing and tracking of contract modifications.
 - i. Creating and distributing meeting minutes.
 - j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
 - k. Management of construction progress photographs.
 - l. Mobile device compatibility, including smartphones and tablets.
 2. Provide up to seven web-based Project software user licenses for use of Owner, Owner's Commissioning Authority, Architect, and Architect's consultants. Provide eight hours of software training at Architect's office for web-based Project software users.

3. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect. Provide data in locked format to prevent further changes.
 4. Provide the following web-based Project software packages under their current published licensing agreements:
 - a. Newforma, Inc.
- C. 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: Construction Manager 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.
 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, Construction Manager, and Architect, within three days of the meeting.
- B. Preconstruction Conference: Construction Manager 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, Construction 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: 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 and existing building.

- 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. First aid.
 - bb. Security.
 - cc. Progress cleaning.
3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- A. Sustainable Design Requirements Coordination Conference: Construction Manager will schedule and conduct a sustainable design coordination conference before starting construction, at a time convenient to Owner, Construction Manager, Architect, and Contractor.
1. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Construction Manager, 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.
- B. 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, Construction Manager, and Owner's Commissioning Authority 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.
- C. Project Closeout Conference: Construction Manager will 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, Construction Manager, 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.
- D. Progress Meetings: Construction Manager will conduct progress meetings at regular intervals.
1. Coordinate dates of meetings with preparation of payment requests.
 2. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority, Construction Manager, 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.
- E. Coordination Meetings: Construction Manager will conduct Project coordination meetings at regular intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
1. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority, Construction Manager, 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 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 utilization.
 - 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.
 - 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

SECTION 01 3200

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 013300 "Submittal Procedures" for submitting schedules and reports.
 2. Section 014000 "Quality Requirements" for submitting a schedule of tests and inspections.

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 the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by Architect.
- 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 when activities can be performed and the critical path of Project.

- 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 the completion of an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. Working electronic copy of schedule file, where indicated.
 - 2. PDF electronic 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. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.
- D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
 - 1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.
- E. 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 all 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 all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 - 3. Total Float Report: List of all activities sorted in ascending order of total float.
 - 4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work until most recent Application for Payment.
- F. Construction Schedule Updating Reports: Submit with Applications for Payment.
- G. Daily Construction Reports: Submit at weekly intervals.

- H. Material Location Reports: Submit at monthly intervals.
- I. Site Condition Reports: Submit at time of discovery of differing conditions.
- J. Unusual Event Reports: Submit at time of unusual event.
- K. Qualification Data: For scheduling consultant.

1.5 QUALITY ASSURANCE

- A. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's construction schedule, including, but not limited to, the following:
 - 1. Review software limitations and content and format for reports.
 - 2. Verify availability of qualified personnel needed to develop and update schedule.
 - 3. Discuss constraints, including work stages area separations and interim milestones.
 - 4. Review delivery dates for Owner-furnished products.
 - 5. Review schedule for work of Owner's separate contracts.
 - 6. Review submittal requirements and procedures.
 - 7. Review time required for review of submittals and resubmittals.
 - 8. Review requirements for tests and inspections by independent testing and inspecting agencies.
 - 9. Review time required for Project closeout and Owner startup procedures, including commissioning activities.
 - 10. Review and finalize list of construction activities to be included in schedule.
 - 11. Review procedures for updating schedule.

1.6 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.

1.7 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- 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 commencement of the Work 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 story 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. Procurement Activities: Include procurement process activities for the following long lead 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.
 3. 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.
 4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
 5. Commissioning Time: Include no fewer than 15 days for commissioning.
 6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's and Construction Manager's administrative procedures necessary for certification of Substantial Completion.
 7. 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. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 2. 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. Seasonal variations.
 - f. Environmental control.
- 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. See Section 012900 "Payment Procedures" for cost reporting and payment procedures.
- F. 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 Contract Time.
- G. 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.
- H. 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, and equipment required to achieve compliance, and date by which recovery will be accomplished.

- I. Distribution: Distribute copies of approved schedule to Architect[, **Construction Manager**,] 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.

1.8 CPM SCHEDULE REQUIREMENTS

- A. General: Prepare network diagrams using AON (activity-on-node) format.
- B. Startup Network Diagram: Submit diagram within 14 days of date established for commencement of the Work. Outline significant construction activities for the first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.
- C. CPM Schedule: Prepare Contractor's Construction Schedule using a time-scaled CPM network analysis diagram for the Work.
 1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 60 days after date established for commencement of the Work.
 - a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Architect's approval of the schedule.
 2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to coordinate with the Contract Time.
- D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.
 1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals.
 - b. Mobilization and demobilization.
 - c. Purchase of materials.
 - d. Delivery.
 - e. Fabrication.
 - f. Utility interruptions.
 - g. Installation.
 - h. Work by Owner that may affect or be affected by Contractor's activities.
 - i. Testing and commissioning.
 - j. Punch list and final completion.
 - k. Activities occurring following final completion.

2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
 3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
 4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
 5. Cost- and Resource-Loading of CPM Schedule: Assign cost to construction activities on the CPM schedule. Do not assign costs to submittal activities. Obtain Architect's approval prior to assigning costs to fabrication and delivery activities. Assign costs under main subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project record documents, sustainable design documentation, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
 - a. Each activity cost shall reflect an appropriate value subject to approval by Architect.
 - b. Total cost assigned to activities shall equal the total Contract Sum.
- E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.
- F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
1. Contractor or subcontractor and the Work or activity.
 2. Description of activity.
 3. Main events of activity.
 4. Immediate preceding and succeeding activities.
 5. Early and late start dates.
 6. Early and late finish dates.
 7. Activity duration in workdays.
 8. Total float or slack time.
 9. Average size of workforce.
 10. Dollar value of activity (coordinated with the schedule of values).
- G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.
 4. Changes in activity durations in workdays.
 5. Changes in the critical path.
 6. Changes in total float or slack time.
 7. Changes in the Contract Time.
- H. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
 2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.

3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
 - a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
 - b. Submit value summary printouts one week before each regularly scheduled progress meeting.

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. Accidents.
 8. Meetings and significant decisions.
 9. Unusual events (see special reports).
 10. Stoppages, delays, shortages, and losses.
 11. Meter readings and similar recordings.
 12. Emergency procedures.
 13. Orders and requests of authorities having jurisdiction.
 14. Change Orders received and implemented.
 15. Construction Change Directives received and implemented.
 16. Services connected and disconnected.
 17. Equipment or system tests and startups.
 18. Partial completions and occupancies.
 19. 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.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 3233

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. Periodic construction photographs.
 - 3. Final completion construction photographs.
 - 4. Preconstruction 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 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 by uploading to web-based project software site. Include copy of key plan indicating each photograph's location and direction.
 - 2. Identification: Provide the following information with each image description in web-based project software site:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect and Construction Manager.
 - 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 by uploading to web-based project software site. Include copy of key plan indicating each video's location and direction.
 - 2. Identification: With each submittal, provide the following information on web-based project software site:
 - a. Name of Project.
 - b. Name and address of photographer.
 - c. Name of Architect and Construction Manager.
 - 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.

1.4 QUALITY ASSURANCE

- A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.

1.5 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, and with vibration-reduction technology. 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 with vibration-reduction technology. 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.

1.6 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 demolition, 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 construction limits before taking construction photographs.
 - 2. Take 20 photographs to show existing conditions adjacent to property before starting the Work.

3. Take 20 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. Periodic Construction Photographs: Take 20 photographs weekly coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.
- E. 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.
- F. Additional Photographs: Architect or Construction Manager 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 to 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.

1.7 CONSTRUCTION VIDEO RECORDINGS

- A. Video Recording Photographer: Engage a qualified videographer to record construction video recordings.
- B. Preconstruction Video Recording: Before starting demolition, record video recording of Project site and surrounding properties from different vantage points, as directed by Architect.
1. Flag construction limits 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 demolition.
 4. Show protection efforts by Contractor.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 3300
SUBMITTAL 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:

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

B. Related Requirements:

1. Section 01 3100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
2. Section 01 3200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
3. Section 01 3233 "Photographic Documentation" for submitting preconstruction photographs, periodic construction photographs, and final completion construction photographs.
4. Section 01 4000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
5. Section 01 7700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
6. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
7. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
8. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.3 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."

- C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 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: 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: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule 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 date of fabrication.
 - h. Scheduled dates for purchasing.
 - i. Scheduled dates for installation.
 - j. Activity or event number.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Architect's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Architect for Contractor's use in preparing submittals.
 - 1. Architect will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings and Project record drawings.
 - a. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 - b. Contractor shall execute a data licensing agreement in the form of AIA Document C106, Digital Data Licensing Agreement.
 - c. The following digital data files will be furnished for each appropriate discipline:
 - 1) Floor plans.
 - 2) Reflected ceiling plans.

- 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 different types of submittals for related parts of the Work 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 required, allow 21 days for initial review of each submittal.
 5. Concurrent Consultant Review: Where 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.
- D. Electronic Submittals: Identify and incorporate information in each electronic submittal file 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.
 - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
 4. Transmittal Form for Electronic Submittals: Use software-generated form from electronic project management software acceptable to Owner, containing the following information:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name of Construction Manager.
 - e. Name of Contractor.
 - f. Name of firm or entity that prepared submittal.
 - g. Names of subcontractor, manufacturer, and supplier.
 - h. Category and type of submittal.
 - i. Submittal purpose and description.

- j. Specification Section number and title.
 - k. Specification paragraph number or drawing designation and generic name for each of multiple items.
 - l. Drawing number and detail references, as appropriate.
 - m. Location(s) where product is to be installed, as appropriate.
 - n. Related physical samples submitted directly.
 - o. Indication of full or partial submittal.
 - p. Transmittal number, numbered consecutively.
 - q. Submittal and transmittal distribution record.
 - r. Other necessary identification.
 - s. Remarks.
5. Metadata: Include the following information as keywords in the electronic submittal file metadata:
- a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- E. Options: Identify options requiring selection by Architect.
- F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- G. 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.
- H. 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.
- I. 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.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
- 1. Post electronic submittals as PDF electronic files directly to Project Web site specifically established for Project.
 - a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

2. Certificates and Certifications Submittals: Provide 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.
 - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
 - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

- B. 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 not suitable 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 showing 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 or concurrent with Samples.
 6. Submit Product Data in the following format:
 - a. PDF electronic file.

- C. 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. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least **8-1/2 by 11 inches (215 by 280 mm)**, but no larger than **30 by 42 inches (750 by 1067 mm)**.
 3. Submit Shop Drawings in the following format:
 - a. PDF electronic file.
 4. BIM File Incorporation: Construction Manager will incorporate Contractor's Shop Drawing files into Building Information Model established for Project.
 - a. Prepare Shop Drawings in the following format: Same digital data software program, version, and operating system as the original Drawings.

- b. Refer to Section 013100 "Project Management and Coordination" for requirements for coordination drawings.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of applicable Specification Section.
 - e. Specification paragraph number and generic name of each item.
 3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
 4. 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.
 5. 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.
 6. 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.
- E. 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.
 5. Submit product schedule in the following format:
 - a. PDF electronic file.
- F. Coordination Drawing Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."
- G. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."
- H. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."
- I. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."
- J. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."
- K. LEED Submittals: Comply with requirements specified in Section 018113.13 "Sustainable Design Requirements - LEED for New Construction and Major Renovations."
- L. 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.
- M. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- N. 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.
- O. 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.
- P. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- Q. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- R. 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.
- S. 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.

- T. 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:
 - 1. Name of evaluation organization.
 - 2. Date of evaluation.
 - 3. Time period when report is in effect.
 - 4. Product and manufacturers' names.
 - 5. Description of product.
 - 6. Test procedures and results.
 - 7. Limitations of use.
- U. 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.
- V. 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 primers and substrate preparation needed for adhesion.
- W. 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.
- X. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 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 Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file and three paper copies 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 File Incorporation: Construction Manager will incorporate delegated-design drawing and data files into Building Information Model established for Project.
 - 1. Prepare delegated-design drawings in the following format: Same digital data software program, version, and operating system as the original Drawings.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action 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. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, 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.

3.2 ARCHITECT'S ACTION

- A. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate 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. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION

SECTION 01 4000
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 inspecting 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 -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, Commissioning Authority, Construction Manager, or authorities having jurisdiction are not limited by provisions of this Section.
 - 4. Specific test and inspection requirements are not specified in this Section.

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 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: 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 trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

- D. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
 - 1. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as freestanding temporary built elements, consisting of multiple products, assemblies, and subassemblies.
 - 2. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings and equipment, and lighting.
- 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.
- F. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or 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 Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- H. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- I. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- J. 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.
- K. 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 or Construction Manager.

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.

1.5 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent

requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for direction before proceeding.

- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be 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. Shop Drawings: For integrated exterior mockups, provide plans, sections, and elevations, indicating materials and size of mockup construction.
 - 1. Indicate manufacturer and model number of individual components.
 - 2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.
- B. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, 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.

1.7 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 sent to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Architect.
 - 2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Architect.
- 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 10 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. Coordinate with Contractor's Construction Schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified full-time 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.
 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 the 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 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, and telephone number 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 inspecting.
 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, and telephone number 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 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, and telephone number 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 whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE

- A. General: 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.

- 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, 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 are similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- 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 installation 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:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
 - e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - f. When testing is complete, remove test specimens, assemblies, and mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect and Commissioning Authority, through Construction Manager, 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 and of size 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 that will be employed during the construction at Project.
 5. Demonstrate the proposed range of aesthetic effects and workmanship.
 6. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 8. Demolish and remove mockups when directed unless otherwise indicated.
- L. Integrated Exterior Mockups: Construct integrated exterior mockup as indicated on Drawings. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials.
- M. Room Mockups: Construct room mockups incorporating required materials and assemblies, finished according to requirements. Provide required lighting and additional lighting where required to enable Architect to evaluate quality of the Work. Provide room mockups of the following rooms:
1. **<Insert room name or description>.**

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 inspecting they are engaged to perform.
 2. Payment for these services will be made from testing and inspecting 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.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
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. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

- a. Contractor shall 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 inspecting 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 inspecting 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. 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."
- D. 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.
- E. 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.
- F. Testing Agency Responsibilities: Cooperate with Architect, Commissioning Authority, Construction Manager, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect, Commissioning Authority, , Construction Manager, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the location 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 any duties of Contractor.
- G. Associated Services: Cooperate with agencies 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 inspecting. 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 inspecting equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.12 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Conducted by a qualified special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews the completeness and adequacy of those procedures to perform the Work.
2. Notifying Architect, Commissioning Authority, , Construction Manager, 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, through Construction Manager, 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 Construction Manager's 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, inspecting, 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

SECTION 01 4200

REFERENCES

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 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.

1.3 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.
- 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.

1.4 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall 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: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall 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. AABC - Associated Air Balance Council; www.aabc.com.
 - 2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
 - 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; (Formerly: ACI International); www.concrete.org
 - 9. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
 - 10. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
 - 11. AF&PA - American Forest & Paper Association; www.afandpa.org.
 - 12. AGA - American Gas Association; www.aga.org.
 - 13. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
 - 14. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
 - 15. AI - Asphalt Institute; www.asphaltinstitute.org.
 - 16. AIA - American Institute of Architects (The); www.aia.org.
 - 17. AISC - American Institute of Steel Construction; www.aisc.org.
 - 18. AISI - American Iron and Steel Institute; www.steel.org.
 - 19. AITC - American Institute of Timber Construction; www.aitc-glulam.org.
 - 20. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
 - 21. ANSI - American National Standards Institute; www.ansi.org.
 - 22. AOSA - Association of Official Seed Analysts, Inc.; www.aosaseed.com.
 - 23. APA - APA - The Engineered Wood Association; www.apawood.org.
 - 24. APA - Architectural Precast Association; www.archprecast.org.
 - 25. API - American Petroleum Institute; www.api.org.
 - 26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
 - 27. ARI - American Refrigeration Institute; (See AHRI).
 - 28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
 - 29. ASCE - American Society of Civil Engineers; www.asce.org.
 - 30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).

31. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
32. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
33. ASSE - American Society of Safety Engineers (The); www.asse.org.
34. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
35. ASTM - ASTM International; www.astm.org.
36. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
37. AWEA - American Wind Energy Association; www.awea.org.
38. AWI - Architectural Woodwork Institute; www.awinet.org.
39. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
40. AWWA - American Water Works Association; www.awwa.org.
41. AWS - American Welding Society; www.aws.org.
42. AWWA - American Water Works Association; www.awwa.org.
43. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
44. BIA - Brick Industry Association (The); www.gobrick.com.
45. BICSI - BICSI, Inc.; www.bicsi.org.
46. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
47. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
48. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bissc.org.
49. CDA - Copper Development Association; www.copper.org.
50. CE - Conformite Europeenne; <http://ec.europa.eu/growth/single-market/ce-marking/>
51. CEA - Canadian Electricity Association; www.electricity.ca.
52. CEA - Consumer Electronics Association; www.ce.org.
53. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
54. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
55. CGA - Compressed Gas Association; www.cganet.com.
56. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
57. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
58. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
59. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
60. CPA - Composite Panel Association; www.pbmdf.com.
61. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
62. CRRC - Cool Roof Rating Council; www.coolroofs.org.
63. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
64. CSA - Canadian Standards Association; www.csa.ca.
65. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csa-international.org.
66. CSI - Construction Specifications Institute (The); www.csinet.org.
67. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
68. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
69. CWC - Composite Wood Council; (See CPA).
70. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
71. DHI - Door and Hardware Institute; www.dhi.org.
72. ECA - Electronic Components Association; (See ECIA).
73. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
74. ECIA - Electronic Components Industry Association; www.eciaonline.org.
75. EIA - Electronic Industries Alliance; (See TIA).
76. EIMA - EIFS Industry Members Association; www.eima.com.
77. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
78. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org.

79. ESTA - Entertainment Services and Technology Association; (See PLASA).
80. ETL - Intertek (See Intertek); www.intertek.com.
81. EVO - Efficiency Valuation Organization; www.evo-world.org.
82. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
83. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
84. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
85. FM Approvals - FM Approvals LLC; www.fmglobal.com.
86. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
87. FRSA - Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.; www.floridarroof.com.
88. FSA - Fluid Sealing Association; www.fluidsealing.com.
89. FSC - Forest Stewardship Council U.S.; www.fscus.org.
90. GA - Gypsum Association; www.gypsum.org.
91. GANA - Glass Association of North America; www.glasswebsite.com.
92. GS - Green Seal; www.greenseal.org.
93. HI - Hydraulic Institute; www.pumps.org.
94. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
95. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
96. HPVA - Hardwood Plywood & Veneer Association; www.hpva.org.
97. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
98. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
99. IAS - International Accreditation Service; www.iasonline.org.
100. IAS - International Approval Services; (See CSA).
101. ICBO - International Conference of Building Officials; (See ICC).
102. ICC - International Code Council; www.iccsafe.org.
103. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
104. ICPA - International Cast Polymer Alliance; www.icpa-hq.org.
105. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
106. IEC - International Electrotechnical Commission; www.iec.ch.
107. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
108. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
109. IESNA - Illuminating Engineering Society of North America; (See IES).
110. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
111. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
112. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
113. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
114. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
115. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
116. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
117. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
118. ISO - International Organization for Standardization; www.iso.org.
119. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
120. ITU - International Telecommunication Union; www.itu.int/home.
121. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
122. LMA - Laminating Materials Association; (See CPA).
123. LPI - Lightning Protection Institute; www.lightning.org.
124. MBMA - Metal Building Manufacturers Association; www.mbma.com.
125. MCA - Metal Construction Association; www.metalconstruction.org.

126. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
127. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
128. MHIA - Material Handling Industry of America; www.mhia.org.
129. MIA - Marble Institute of America; www.marble-institute.com.
130. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
131. MPI - Master Painters Institute; www.paintinfo.com.
132. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
133. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
134. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
135. NADCA - National Air Duct Cleaners Association; www.nadca.com.
136. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
137. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
138. NBI - New Buildings Institute; www.newbuildings.org.
139. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
140. NCMA - National Concrete Masonry Association; www.ncma.org.
141. NEBB - National Environmental Balancing Bureau; www.nebb.org.
142. NECA - National Electrical Contractors Association; www.necanet.org.
143. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
144. NEMA - National Electrical Manufacturers Association; www.nema.org.
145. NETA - InterNational Electrical Testing Association; www.netaworld.org.
146. NFHS - National Federation of State High School Associations; www.nfhs.org.
147. NFPA - National Fire Protection Association; www.nfpa.org.
148. NFPA - NFPA International; (See NFPA).
149. NFRC - National Fenestration Rating Council; www.nfrc.org.
150. NHLA - National Hardwood Lumber Association; www.nhla.com.
151. NLGA - National Lumber Grades Authority; www.nlga.org.
152. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
153. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
154. NRCA - National Roofing Contractors Association; www.nrca.net.
155. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
156. NSF - NSF International; www.nsf.org.
157. NSPE - National Society of Professional Engineers; www.nspe.org.
158. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
159. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
160. NWFA - National Wood Flooring Association; www.nwfa.org.
161. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
162. PDI - Plumbing & Drainage Institute; www.pdionline.org.
163. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); <http://www.plasa.org>.
164. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
165. RFCI - Resilient Floor Covering Institute; www.rfci.com.
166. RIS - Redwood Inspection Service; www.redwoodinspection.com.
167. SAE - SAE International; www.sae.org.
168. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
169. SDI - Steel Deck Institute; www.sdi.org.
170. SDI - Steel Door Institute; www.steeldoor.org.
171. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
172. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
173. SIA - Security Industry Association; www.siaonline.org.
174. SJI - Steel Joist Institute; www.steeljoist.org.
175. SMA - Screen Manufacturers Association; www.smainfo.org.

176. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
 177. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
 178. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
 179. SPIB - Southern Pine Inspection Bureau; www.spib.org.
 180. SPRI - Single Ply Roofing Industry; www.spri.org.
 181. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
 182. SSINA - Specialty Steel Industry of North America; www.ssina.com.
 183. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
 184. STI - Steel Tank Institute; www.steeltank.com.
 185. SWI - Steel Window Institute; www.steelwindows.com.
 186. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
 187. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
 188. TCNA - Tile Council of North America, Inc.; www.tileusa.com.
 189. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
 190. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
 191. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
 192. TMS - The Masonry Society; www.masonrysociety.org.
 193. TPI - Truss Plate Institute; www.tpinst.org.
 194. TPI - Turfgrass Producers International; www.turfgrassod.org.
 195. TRI - Tile Roofing Institute; www.tilerroofing.org.
 196. UL - Underwriters Laboratories Inc.; <http://www.ul.com>.
 197. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
 198. USAV - USA Volleyball; www.usavolleyball.org.
 199. USGBC - U.S. Green Building Council; www.usgbc.org.
 200. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
 201. WASTEC - Waste Equipment Technology Association; www.wastec.org.
 202. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
 203. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
 204. WDMA - Window & Door Manufacturers Association; www.wdma.com.
 205. WI - Woodwork Institute; www.wicnet.org.
 206. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
 207. WWPA - Western Wood Products Association; www.wwpa.org.
- C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall 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. DIN - Deutsches Institut für Normung e.V.; www.din.de.
 2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
 3. ICC - International Code Council; www.iccsafe.org.
 4. 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 shall 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. COE - Army Corps of Engineers; www.usace.army.mil.
 2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.

3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
4. DOD - Department of Defense; <http://dodssp.daps.dla.mil>.
5. DOE - Department of Energy; www.energy.gov.
6. EPA - Environmental Protection Agency; www.epa.gov.
7. FAA - Federal Aviation Administration; www.faa.gov.
8. FG - Federal Government Publications; www.gpo.gov.
9. GSA - General Services Administration; www.gsa.gov.
10. HUD - Department of Housing and Urban Development; www.hud.gov.
11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; <http://eetd.lbl.gov>.
12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
13. SD - Department of State; www.state.gov.
14. TRB - Transportation Research Board; National Cooperative Highway Research Program; www.trb.org.
15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
17. USDJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
18. USP - U.S. Pharmacopeia; www.usp.org.
19. USPS - United States Postal Service; www.usps.com.

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall 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 Government Printing Office; www.gpo.gov/fdsys.
2. DOD - Department of Defense; Military Specifications and Standards; Available from Department of Defense Single Stock Point; <http://dodssp.daps.dla.mil>.
3. DSCC - Defense Supply Center Columbus; (See FS).
4. FED-STD - Federal Standard; (See FS).
5. FS - Federal Specification; Available from Department of Defense Single Stock Point; <http://dodssp.daps.dla.mil>.
 - a. Available from Defense Standardization Program; www.dsp.dla.mil.
 - b. Available from General Services Administration; www.gsa.gov.
 - c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org/ccb.
6. MILSPEC - Military Specification and Standards; (See DOD).
7. USAB - United States Access Board; www.access-board.gov.
8. 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 shall 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. CBHF; State of California; Department of Consumer Affairs; Bureau of Electronic Appliance and Repair, Home Furnishings and Thermal Insulation; www.bearhfti.ca.gov.

2. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.calregs.com.
3. CDHS; California Department of Health Services; (See CDPH).
4. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cal-iaq.org.
5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
6. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
7. TFS; Texas Forest Service; Forest Resource Development and Sustainable Forestry; <http://txforests-service.tamu.edu>.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 5000

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. General: Installation and removal of 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, Owner's construction forces, Architect, occupants of Project, testing agencies, and authorities having jurisdiction.
- B. 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.
- C. 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 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, typestyles, graphic elements, and message content.

- D. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of 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-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.
- G. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
 - 1. Locations of dust-control partitions at each phase of work.
 - 2. HVAC system isolation schematic drawing.
 - 3. Location of proposed air-filtration system discharge.
 - 4. Waste handling procedures.
 - 5. Other dust-control measures.

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.
- C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

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. 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 rails.

- B. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain link fence, sized to height of fence, in color selected by Architect from manufacturer's standard colors.
- C. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil (0.25-mm) minimum thickness, with flame-spread rating of 15 or less per ASTM E 84 and passing NFPA 701 Test Method 2.
- D. Dust-Control Adhesive-Surface Walk-off Mats: Provide mats minimum 36 by 60 inches (914 by 1624 mm).
- E. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 TEMPORARY FACILITIES

- A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:
 - 1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
 - 2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- (1.2-m-) square tack and marker boards.
 - 3. Drinking water and private toilet.
 - 4. Coffee machine and supplies.
 - 5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
 - 6. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.
- C. 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 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".
- C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

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. See other Sections for disposition of salvaged materials that are designated as Owner's property.

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.
- 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. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. 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.
- E. Sanitary Facilities: Provide temporary toilets, wash 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. Toilets: Use of Owner's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.

- F. 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.
- G. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
1. Prior to commencing work, isolate the HVAC system in area where work is to be performed.
 - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
 - b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- H. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
- I. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
- J. 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.
 2. Install lighting for Project identification sign.
- K. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install WiFi cell phone access equipment and one land-based telephone line(s) for each field office.
1. Provide additional telephone lines for the following:
 - a. Provide a dedicated telephone line for each facsimile machine in each field office.
 2. At each telephone, post a list of important telephone numbers.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Contractor's home office.
 - d. Contractor's emergency after-hours telephone number.
 - e. Architect's office.
 - f. Engineers' offices.
 - g. Owner's office.
 - h. Principal subcontractors' field and home offices.

3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.
- L. Electronic Communication Service: Provide a desktop computer in the primary field office adequate for use by Architect and Owner to access Project electronic documents and maintain electronic communications. Equip computer with not less than the following:
 1. Processor: Intel Core i5 or i7.
 2. Memory: 4 gigabyte.
 3. Disk Storage: 500 gigabyte hard-disk drive and combination DVD-RW/CD-RW drive.
 4. Display: 24-inch (610-mm) LCD monitor with 256-Mb dedicated video RAM.
 5. Full-size keyboard and mouse.
 6. Network Connectivity: 10/100BaseT Ethernet.
 7. Operating System: Microsoft Windows 7 Professional.
 8. Productivity Software:
 - a. Microsoft Office Professional, 2010 or higher, including Word, Excel, and Outlook.
 - b. Adobe Reader 11.0 or higher.
 - c. WinZip 7.0 or higher.
 9. Printer: "All-in-one" unit equipped with printer server, combining color printing, photocopying, scanning, and faxing, or separate units for each of these three functions.
 10. Internet Service: Broadband modem, router and ISP, equipped with hardware firewall, providing minimum 1.0 Mbps upload and 15 Mbps download speeds at each computer.
 11. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.
 12. Backup: External hard drive, minimum 2 terrabyte, with automated backup software providing daily backups.

3.4 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
 1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines that is noncombustible according to ASTM E 136. 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 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 according to 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 according to 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: Use designated areas of Owner's existing parking areas for construction personnel.
- F. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 2. Remove snow and ice as required to minimize accumulations.
- 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 touchup 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. 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.
- J. Temporary Elevator Use: See Section 142100 "Electric Traction Elevators," for temporary use of new elevators.
- K. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- L. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.
1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.
- 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.
- 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 2003 EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Section 311000 "Site Clearing."
- D. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings, and requirements of 2003 EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
 - 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.
- E. 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.
- F. Tree and Plant Protection: Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."
- A. 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.
- B. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people and animals 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.
- C. 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 work day.

- D. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- E. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- F. 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.
- G. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.
 - 1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
 - 2. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 - 3. Insulate partitions to control noise transmission to occupied areas.
 - 4. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
 - 5. Protect air-handling equipment.
 - 6. Provide walk-off mats at each entrance through temporary partition.
- H. 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.
 - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to 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. Contractor's Moisture-Protection Plan: 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 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.
- B. Exposed Construction Phase: 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 Phase: 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, replace, or clean stored or installed material that begins to grow mold.
 7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.
- D. Controlled Construction Phase of Construction: 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 permanent HVAC system to control humidity.
 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 hours are considered defective.
 - 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 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
 - c. Remove materials that can not be completely restored to their manufactured moisture level within 48 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

SECTION 01 5639

TREE PROTECTION

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 protection of trees that interfere with, or are affected in any way by, execution of the Work, whether temporary or new construction.
- B. Related Sections include the following:
 - 1. Division 31 Section "Site Clearing".
 - 2. Division 31 Section "Earthwork".
 - 3. Division 32 Section "Soil Preparation".
 - 4. Division 32 Section "Plants".

1.3 DEFINITIONS

- A. Certified Arborist: Credential of an individual arborist issued and administered by the International Society of Arboriculture. This credential must be current and valid to qualify to use the copyrighted designation of "Certified Arborist". Refer to www.isa-arbor.com for additional information.
- B. Project Arborist: Highly specialized Arboricultural firm contracted to implement the approved tree preservation specifications on site. All crews conducting arboricultural operations on site shall consist of at least one Certified Arborist who directly oversees all work by that crew. Arboricultural operations include, but are not limited to, pruning, tree protection device installation and maintenance (fence, matting, etc.), root pruning, air tool root excavation/exploration, soil care activities, soil testing, mulch application, tree inspections, pesticide/chemical applications and tree removal. Special qualification submittals are required for review and approval below.
- C. Tree Protection Area (TPA): Area indicated on Drawings surrounding individual trees or groups of trees to be protected during construction. TPAs are outside the Limits of Disturbance (LOD).
- A. Critical Root Zone (CRZ): As determined based upon investigative root tracings by the Project Arborist for this site.
- B. Supersonic Airtool (SSAT): Hand held tool designed to focus highly compressed air (90-125 psi) provided from a large diesel air compressor (185-375 cfm) at speeds close to Mach 2

(approx. 1400 mph) at the tip of the tool. Recently in wide use by arboricultural firms and consultants for multiple purposes including but not limited to the following: root collar investigation, CRZ investigation, root pruning especially large roots > 1.5" diameter or root pruning where existing underground cables or conduits are located, radial mulching and restoration of compacted soils, insertion of piers, footers, and pilings within the protected CRZs during construction.

- C. **Selective Tree Removals:** Action to remove trees designated for removal by the College's arborist selected from inside the TPAs. Designated trees shall be taken down sectionally, or directionally felled to minimize damage to adjacent tree canopies, root systems, or adjacent structures by a qualified contract arborist. See also "Ground Plane Improvement".
- D. **Ground Plane Improvement:** Within Tree Protection Areas as designated by the Landscape Architect and Owner, perform control of invasive shrubs, vines, and removal of select dead, dying, and broken trees during or prior to construction.
- E. **Crown Pruning:** Action to provide specific crown pruning of designated limbs for tree health, hazard reduction, and / or construction clearance per the College's arborist.
- F. **Supportive Cabling:** Installation of supportive cabling of designated tree branch due to weak unions. The prime focus is trees and limbs near pedestrians, vehicles, or site improvements.
- G. **Root Pruning:** Action to provide a more suitable cut for protected tree roots so as to not rip or tear roots during excavations and grading with standard construction equipment.
- H. **Mulching of Trees:** Product applied to area surrounding trees designated by Project Arborist to afford increased moisture- holding capacity, minimize soil compaction, and increase needed organic composition due to impacts from construction or transplanting.
- I. **Soil Amendments:** Various product components for application to existing protected trees, for the purpose of increasing tree health and overcoming construction stress.
- J. **Plant Growth Regulator (*Paclobutrazol*):** Products applied to trees designated by the College's arborist used to regulate plant growth in such a way as to restrict canopy growth and free stored or produced energy for other uses in the tree. For highly impacted trees, this means more energy may be made available for fibrous root growth (to combat root loss), thicker darker leaves (allowing for increased photosynthesis, and increased drought tolerance), and pest suppression (often an issue with construction stressed trees); among countless other potential benefits.
- K. **Soil Decompaction / Radial Mulching:** Action to provide pneumatic decompaction of soils surrounding trees designated by Project Arborist employing the Supersonic Airtool (SSAT) to allow incorporation of soil amendments, increased biological activity, increased moisture absorption, and aeration of the roots system.
- L. **Soil Biological Testing:** Analysis of existing site soil by approved laboratory within areas of TPAs to assess biological health of soils as well as periodically over the maintenance time of the trees.

- M. Compost Tea Testing: Sample of tea to be sent to approved lab for testing. Results to be submitted for review within set prescribed ranges as follows:
1. Decomposers:
 - a. Active bacterial biomass 10 – 150 ug per ml
 - b. Total bacterial biomass 150 - 3000 ug per ml
 - c. Active fungal biomass 2 - 10 ug per ml
 - d. Total fungal biomass 2 - 20 ug per ml
 2. Predators – Protozoa and Nematodes:
 - a. Flagellates 1000 per ml
 - b. Amoebae 1000 per ml
 - c. Ciliates 20-50 per ml
 - d. Nematodes 2-10 per ml (no root feeders)
 - e. E-coli should be undetectable
- N. “Non- Invasive” attachment” for SuperSilt Fence / Silt Fence: Method of attachment of Supersilt Fence or Silt fence to the Temporary Root Protection Matting or Root Aeration Matting that disallows entrenching the bottom of the fabric thereby not severing of roots from protected adjacent trees. Silt socks (see below) can be added to or use in lieu of silt fence / supersilt fence upon approval of reviewing agency.
- O. Silt Socks (such as SILTSOXX™): for the purpose of perimeter erosion control, Silt Socks are a “non- invasive” sediment-trapping device (in appearance as a mesh “tube” of varying prescribed units of diameter and length) using filtermedia materials applied with a pneumatic blower device or equivalent. Silt Socks trap sediment by filtering the water passing through the Silt Socks also allowing water to pond, creating a settling of solids behind Silt Socks. Silt Socks may also be used in sensitive environmental areas, such as where to protect the roots of adjacent trees from standard installations of silt or supersilt fence. Filter Media used in Silt Socks also has the ability to bind various contaminants contained in runoff.
- P. Heavy Duty Root Aeration Mat (HD RAM): Geocomposites products that are installed with the purpose of distributing compressive loads, thereby resisting compaction of soil CBR, provide atmospheric air / gas exchange to top soil and roots, by maximizing airflow throughout the core to buried CRZs of protected trees. This prevents suffocation of roots under grade fills and pavement sections such as parking lots and driveways. It consists of an extruded high density polyethylene diamond mesh inner grid covered by 2 layers of non-woven, needle punched, geotextile fabric.
- Q. Temporary Limb Guying: Action of bending and temporary securing designated tree limbs out of the range of service or construction vehicles for the duration of construction.
- R. Supplemental Watering: Action taken for high impact trees of significance during seasonal drought times of project construction. Based upon the number and size of trees various strategies can be considered to maintain adequate soil moisture during these times.
- S. Monitor and Treat Tree Health: Periodic inspections and treatments for pertinent insects, disease, soil moisture levels, weather, and health changes on all trees as designated by the College’s arborist.

- T. Supersonic Airtool (SSAT) Excavation: Activity utilizing the SSAT for excavating within TPAs with minimal impact to roots during installation of underground utilities such as site electrical conduits and water lines.
- U. Remedial Measures: Activities prescribed to remediate construction and / or environmental events of impact to the TPAs and CRZs that are beyond those indicated in construction documents. Such events may be unintended or are often accidental or weather related in nature and may include silt accumulation, soil compaction, equipment rutting of soil, and soils contamination to name a few.
- V. California Bearing Ratio (CBR): The CBR rating was developed for measuring the load-bearing capacity of soils used for building roads. It uses a penetration test for the evaluation of the mechanical strength of road sub grades and base courses. It was developed by the California Department of Transportation before World War II.
- W. Limit of Disturbance (LOD): Defined graphically on agency approved site plan drawings as the limit of work for all equipment or materials relating to disturbing the existing grade. On site this is demarcated by perimeter control fences such as silt fence and / or tree protection fences. Therefore the LOD is the interface between trees to be protected and trees to be removed.

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 as pertinent.
- B. Qualification Data: For Project Arborist Qualifications: Submit resumes and detailed qualifications from minimum two or team individuals assigned to this project as detailed below. Due to the complexity of technical and leadership issues for these trees, standard arboricultural experience may not qualify.
 - 2. Provide references for above from a minimum of 4 commercial, nongovernmental or governmental projects within the project region for who similar tree preservation programs have been successfully implemented.
 - 3. Include the following information:
 - a. Project name, location
 - b. Project size
 - c. Number of trees involved
 - d. Relevant photos or aerials
 - e. Tree preservation budget
 - f. Scope of services provided
 - g. Name and contact number for project owner, designer, or contractor
- C. Monthly Tree Work Plan: Project Arborist to provide tree by tree listing of projected proposed Stress Reduction and Protection Measures to be installed in each successive month of the project.
- D. Certification of Monthly Tree Work: Monthly Tree Report from Project Arborist for each tree certifying that prior month's protection and stress reduction measures were installed or any changes from Monthly Work Plan and reasons. Monthly Reports to include:

4. Date (month / year) of material application or protection measure
 5. Total amount of material applied (gallons, linear feet, pounds, sq ft, cu yds)
 6. Tree number(s);
 7. Name of certified applicator and / or certified arborist on site during application.
 8. This report pertains to the application of all materials contained within this section as well as supplemental watering.
- E. Soil Sample: Submit sample of representative existing soil for analysis during site work phase of this project. Take the samples during April through October or prior to commencement. Take representative soil samples and combine from all areas of or key protected trees. Samples and procedures from website below or equivalent firm as follows. Forward reports to Landscape Architect:
- SOIL FOODWEB NEW YORK, INC 1645
Washington Ave. Bohemia, NY 11716
Tele.: (631) 750-1553 Fax: (631) 750- 1554
Email: soilfoodwebny@aol.com
- F. Compost Tea Testing: Submit test results from the batch of compost tea applied to same as above. Document with date brewed, label of ingredients, and name and certification number or licensed pesticide applicator certifying above.
- G. Shop Drawings / Cut Sheets: For the following applicable construction procedures with tree protection methods indicated, include location by survey of trees to be protected, dimensions of individual components and profiles, construction details, sequencing, and material descriptions.
1. Protection of tree CRZs during installation of new irrigation, plantings, and hardscape within TPAs.
 2. Installation of Root Aeration Matting under proposed walks within CRZs.
 3. Protection of trees from dewatering required by excavations adjacent to TPAs.
 4. Protection of trees for perimeter permanent fence layout, clearing, and installation.
 5. Sequence, areas for, and methods for removal of heavy debris for Ground Plane Improvement outside of LOD.
 6. Layout and method of clearing, tree protection methods, and restoration disturbed area due to storm drain outfall installation through Tree Protection Area.
 7. Any equipment access, storage, and stockpile within TPAs during construction activities.
- H. Certification: From the College's arborist that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
- I. Maintenance Recommendations: From a qualified arborist for care and protection of trees affected by construction during and after completing the Work.

1.5 QUALITY ASSURANCE

- A. Tree Service Qualifications: An experienced tree service firm that has successfully completed tree protection and trimming work similar to that required for this Project and that will assign an experienced, certified arborist to Project site on a full-time basis during execution of the Work.
- B. General Arborist Qualifications: An arborist certified by the International Society of Arboriculture (ISA) or licensed in the jurisdiction where Project is located.

1. Contract Arborist Qualifications: Provide names of each individual to comply with the following: Provide individual(s) names, certifications, and each anticipated role in this project. "Role(s)" shall be defined as one or more of the following:
 - h. Project Manager
 - i. Technical oversight
 - j. Field Applicator / Technician
 - k. PhD or advanced degree in Technical / Research / Lab Advisor
 2. For each member, list a minimum of five construction projects and a minimum three years' experience in the following technical applications:
 - l. Compost tea brewing and applications
 - m. Supersonic Airtool Excavations for underground utilities exceeding 24" depth
 - n. Root Protection Matting for Heavy Duty or Extreme Duty applications
 - o. Root Aeration Matting for structural grade fills
 - p. Supplemental watering systems capable of 100-250 gallons per week for mature trees
 - q. Supersonic Airtool Soil Decompaction of mature trees equal to or exceeding 24" diameter on historic or high profile sites
- C. Fertilizer and pesticides will be applied in strict accordance with the manufacturers label instructions and applicable federal, state, and local requirements. Fertilizer, soil conditioners, and pesticide applications must be approved by the Owner prior to application. Material Safety Data Sheets (MSDS) will be available for fertilizers and pesticides in the project arborists' possession while on the site performing applications.
- D. Should Compost Tea tests indicate insufficient results per specifications requirements Contract Arborist shall reapply and re-test materials for re-submission and approval
- E. Preinstallation Conference(s): Conduct conferences at Project site to comply with requirements in Division 1 Section "Project Meetings."
1. The contractor is required to meet with the Owner, Architect, consultant, representatives of authorities having jurisdiction and other concerned entities at the site prior to beginning site preparation and tree protection work to review all work procedures, access and haul routes, tree trimming procedures, tree protection measures and responsibilities. Notify participants at least three working days before convening conference. Record discussions and agreements and furnish a copy to each participant.

1.6 REFERENCES

- A. Publications listed herein are part of this work to extent referenced:
1. ANSI A300 Standard Practices for Trees, Shrubs, and Other Woody Plant Maintenance
 2. Part 1-2001, Tree Pruning
 3. Part 2-3004, Fertilization
 4. Part 3-2000, Cabling, Bracing, Guying of Established Trees
 5. Part 4-2002, Lightning Protection Systems
 6. ANSI Z133.1-1994 and most recent updates, Tree Care Operations – Safety Requirements

1.5 PROJECT CONDITIONS

- A. Tree protection fencing shall define a specific protection zone for each tree or groups of trees. Fences are to remain until all site work had been completed. Fences may not be relocated or removed without the written permission of the Landscape Architect.
- B. Penalties for parking, equipment storage and materials storage within the authorized zones (including within tree protection zones):

Due to the sensitivity of plant communities, riparian environments and historic tree specimens on The College's campus, the General Contractor and all subcontractors will be required to take full responsibility for enforcing a zero-tolerance policy towards parking of vehicles or storage of equipment or materials in areas not specially designated for parking or contractor lay-down. Each violation of this prohibition shall result in a penalty of \$1,000. If additional parking or lay-down area is required in the course of the project, the Contractor shall contact the Owner and obtain written permission before proceeding to park or store in additional areas.

- C. Penalties for damages to existing trees or shrubs to remain:

The Project Manager is responsible for monitoring the site and reporting any prohibited practices and damage during the construction process to the University Arborist. The University Arborist will also make periodic site visits. Damage to campus trees will include any of the prohibited practices listed above and will be determined by the University's Arborist. The Project Manager will be notified by the University Arborist of the damage assessment and will issue a deductive change order to contract for the amount of damages.

Except where root pruning or trimming of branches is required by work and directed as performed by The College's horticultural or one of their subcontractors, any injury to roots or branches of existing trees or shrubs to remain that is caused by construction operations or by the activities of the contractor or subcontractors shall result in a penalty. The value of tree damage will be assessed and fines levied up to 100% of the value listed below:

1. 1"-3" caliper \$200/Inch
2. 3"-6" caliper \$300/Inch
3. 6"-9" caliper \$400/Inch
4. 9"-12" caliper \$500/Inch
5. 12"-15" caliper \$600/Inch
6. 15" DBH or more \$700/Inch

- D. Penalties for critical damages to existing trees or shrubs to remain:

If, in the estimation of the Owner, the contractor damages an existing tree or shrub to remain to the extent that its survival is uncertain, the contractor shall be required to supply and install a replacement specimen of the same size and species/cultivar that is satisfactory to the College or designated professional and the Landscape Architect (supplied and installed per the planting specifications and drawings) or make in lieu of payments amounting to 3 times the current market cost of the plant.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Topsoil: See Division 32 Section "Soil Preparation"

- B. Compost: See Division 32 Section "Soil Preparation"
- C. Heavy Duty Root Aeration Matting
 - 1. Inner Core such as Tenax Grass Protection Mesh:
 - a. Diamond mesh of High Density Polyethylene Virgin Vinyl
 - b. Pitch– 1 1/8" Machine Direction (MD) and 3/4" Transverse Direction (TD)
 - c. Thickness - .54"
 - d. Tensile strength – MD: TD
 - e. Breakage Strength – 890 lb/ft: 450 lb/ft
 - f. Breakage Strain - >20%; >85%
 - 2. Geotextile Coverings
 - a. Non-woven, needle punched fabric
 - b. Top sheet – 8 oz or as prescribed by geotechnical specialist
 - c. Bottom sheet – 4 oz. or as prescribed by geotechnical specialist.
 - 3. Anchor pins – 12-18" staples or earth nails with washers
- D. Temporary Tree Protection Fence
 - 1. Metallic-coated steel chain link fence fabric
 - a. 11-12 gauge wire fabric
 - b. 6 feet fabric height
 - c. 6 feet high, 2.5 inch diameter line posts @ 10 ft. on center
 - d. All posts to be force driven into ground to a minimum 24 inch depth
 - e. Terminal and corner posts to be 6 feet high, 4 inch diameter, schedule 40 pipe
 - f. Horizontal bar top rail required if construction period is longer than 8 months
 - g. Metal clips
 - h. Hog ring ties
 - i. 6 foot wide maintenance gates and other accessories for a temporary fence system
- E. Temporary Light Duty Protection Fence: 48" ht, 14 gauge, 4"x2" welded wire galvanized fabric with 6' steel T-posts, metal wire clips.
- F. Tree Protection Signs: made of durable material to last the construction duration, minimum 18" x 18" with bright contrasting colors providing notification of limits of tree protection area and listing construction activities limited from the tree protection areas. Contact information for responsible party is included. Bi-lingual principal warning may be required by Owner or local agency. Do not attach to trees. Attach principally a maximum of 50' apart with a minimum of one per side facing the construction activities.
- G. Mulch for core aerating: PHC Vertimulch
- H. Compost: High fungal bulk material not purchased from stores in bags produced in local composting facility. Minimum 24 months aged and aerated. Submittal to include sample biological analysis from not more than 12 months prior from same facility. Submittal to include parent materials, number of grindings, duration and frequency of composting /aeration.
- I. Hardwood Destructive Borer/Beetle Control
 - 1. Imidacloprid such as Merit or approved equal.
- J. Plant Growth Regulator (Paclobutrazol)
 - 1. Trade name 'Cambistat' or approved equal.
- K. Soil Amendments / Compost Tea

1. A mixture of water, compost, and other additives conducive to the rapid reproduction of bacteria, fungi, and other organisms as defined below, brewed while being infused with air. Compost tea shall be made and applied by a contractor, approved by the Architect's Project Forester, experienced in the production and application of compost tea for use in landscape applications.
2. Water shall be de-chlorinated by allowing the water to sit in an open topped vat for a minimum of 24 hours to allow the chlorine to evaporate.
3. Compost and other additives shall be capable of producing the defined levels of organisms after 24 hours of brewing. Levels of organisms in the tea shall be confirmed by assay performed by Agricultural Service Laboratory.
4. Infuse air continuously thru the brewing liquid during the brewing and storage period. Maintain 6 ppm oxygen during the brew cycle and storage period.
5. Tea application should be applied no later than 8 hours after the completion of brewing.
6. Brewed compost tea is a concentrated material and must be diluted as required in section "Installation of Compost Tea".
7. Liquid Kelp: Nature's Essence LSC or equivalent.
8. Nature's Essence SEP powdered Seaweed extract.
9. Fish hydrolysate such as FH 2-3-1 or equivalent.
10. Granular Humate such as Hum- Amend SG or equivalent.
11. Liquid Humate: Terra Vita SP-90 soluble humic acid powder or liquid form- Terra Vita LC-10 Plus 7 or equivalent.

PART 3 - EXECUTION

3.1 TREE PROTECTION AND STRESS REDUCTION MEASURES

- A. Project arborist shall determine specific measures for each tree, and shall submit for approval by the College's arborist. Installation of the following measures shall be performed in the field by an ISA Certified Arborist approved from submittal.
- B. Coordination of Temporary Tree and Plant Protection to be coordinated by the Project Arborist. Coordination to include but not limited to the following:
 1. Existing underground utility marker conflicts brought to the attention of the Contractor for resolution as well uncovered underground utilities as a result of work.
 2. Layout location of tree protection measures based upon proposed construction and methods of construction for that area and in accordance with all College standards for tree protection.
 3. Site walk with the College's arborist and Contractor to verify location of all tree protection measures prior to execution and are in accordance with the Tree Protection Plan. Notify Contractor and the College's arborist if construction adjacent to tree protection does not appear to follow specifications or prior agreement or conflicts with tree protection seem eminent.
 4. Coordinate with Contractor and Owner for access of deliveries, crews, equipment, start up, and cleanup of each item of work. Provide as built drawings of locations of all tree protection measures. Attend progress meetings as requested.
 5. Provide submittals as required. Notify Contractor and the College's arborist of any breach or damage to tree protection requiring attention.
 6. Coordination with Landscape Architect and the College's arborist for refinement of GPI scope and locations.
 7. Coordination with landscape and utility trades for the location, sequencing, and requirements of work in TPAs to provide SSAT excavation and root investigation.

- C. Selective removals of trees and shrubs or hedges shall be designated as Removal By Arborist (RBA) and shall be marked in red for review and approval by Landscape Architect and The College's arborist. Project arborist shall coordinate with The College's arborist to determine specific trees for selective removal.
1. Trees designated RBA outside the LOD shall be taken down by section, or directionally felled to minimize damage to adjacent tree canopies or root systems by a qualified contract arborist. Damage to adjacent trees shall be reviewed by The College's arborist and Landscape Architect for remedial recommendations or replacement.
 2. All work shall be done by hand or crane operated equipment.
 3. Motorized equipment shall operate inside the LOD or on existing pavement and not enter tree protection areas without prior approval. Temporary root protection matting and / or low pressure rubber tracks may be required for such access to prevent rutting and compaction.
 4. Stumps outside the LOD are to be cut low to the ground. Stumps within the LOD are to be ground to 12" below grade and grindings raked and removed from site; backfill holes with approved planting mix and seed per the Contract Documents. Coordinate with the Landscape Architect and The College's arborist for select stumps inside the TPA for stump grinding.
 5. Removal of shrubs and hedges designated for removal shall be cut and stumps ground out or hand dug to remove stumps. Verification with Landscape Architect is required prior to removal.
 6. Wood debris from this work shall be dealt with in one of three following manners as determined by the Architect or Owner:
 - a. Bring wood inside LOD prior to perimeter control establishment for staging for the clearing contractor to dispose per applicable contract scope;
 - b. Cut and naturalize in small (six foot maximum) segments staged near 50' outside the LOD. Limit average stack or piles to less than three feet height.
 - c. Remove from site.
- D. Ground Plane Improvement: Clean - up and removal of dead, leaning, decayed, and downed woody debris, invasives, and woody vines within 20 feet outside of the LOD.
1. All work shall be performed by the Project Arborist.
 2. Limits of work to be reviewed and approved by the Landscape Architect and Owner prior to start up and prior to completion.
 3. Debris shall be oriented and piled so as to facilitate the processing of the debris by the site work contractor per project document specifications.
 4. Use of equipment into the tree protection areas for removal of woody debris is strictly limited to small rubber tracked skid steers and mini excavators with grapples or thumbs. Smaller debris should be cut and stacked by hand to minimize maneuvering and turning of equipment. No equipment should be operating while soils are moist from recent rains or snow melts unless root protection matting or wood chips are employed to prevent rutting.
 5. Rutting or disturbance from dragging debris or equipment operation that is observable from the LOD should be roughly raked to not exceed 2" depth and covered with compost.
 6. Downed logs and debris flush with grade are to be left. Logs and debris partially in the LOD can be cut at the LOD for partial removal.
 7. Existing overturned stumps within the designated areas are to be reviewed and approved by the Landscape Architect or Owner for removal designation or left in place.
 8. Trees are to be cut low to the grade and stumps left in place.
 9. Identify and mark shrubs and trees to be controlled or removed to avoid confusion.
 10. Employ a combination of cutting, herbicide treatments, and mowing dependent upon size, season, and proximity to adjacent protected trees and native shrubs. Minimum of three treatments per year- spring, summer, fall.

11. Invasive weeds, shrubs, and vines to be controlled may include but are not limited to the following:
 - a. Bush honeysuckle
 - b. Privet shrub
 - c. Multi-flora rose
 - d. Japanese barberry
 - e. Japanese knotweed
 - f. Porcelain berry
 - g. Oriental bittersweet
 - h. Garlic mustard
 12. Application of herbicide treatments shall be by licensed pesticide applicator.
 - a. Personal protective gear must follow state and label requirements.
- E. Pruning and Supportive Cabling: shall be Cleaning Pruning, Clearance Pruning, and/or Restoration Pruning and shall be in conformance with current ANSI A300 standards and ISA Best Management Practices.
1. Pruning shall remove only dead, dying, damaged or broken branches greater than 1"-1.5" in diameter of designated trees for the purpose of reducing risk and to improve overall tree health. Removal of live foliage is not anticipated unless a weak or decayed live limb is at issue.
 2. Pruning shall not remove interior branching except as otherwise stated.
 3. Pruning for specific clearance over proposed boardwalk shall be 8' height above walk and 13' above drives. Pruning or guying up of specimen trees for equipment or materials access shall be reviewed and approved by the Landscape Architect and the College's arborist.
 4. Prior to climbing any tree a risk assessment will be performed using visual, sounding, or basic drilling as needed by the Project Arborist
- F. Temporary Guying of limbs for construction clearance:
1. Identify specific limbs to be temporary guyed for approval by Contractor and the College's arborist. Provide plan location, tree description and photo, and specific reason for guying in Monthly Work Plan and end of month report. Guying material / method shall not injure bark of tree. The College's arborist shall monitor startup of construction activity for trees requiring guying. Remove guying immediately once construction work is complete.
- G. Root Pruning:
1. Root pruning shall occur only where grades are to be cut below existing grades along the LOD or edge of proposed structure or utility excavation within critical root zones of trees within Tree Preservation Areas. Root Pruning shall either be mechanical methods or by the use of SSAT excavation for hand pruning or as specified herein.
 2. Mechanical root pruning shall be motorized rock saw or narrow trencher with sharpened blades.
 3. For the SSAT excavation root pruning sufficient moisture is necessary for reducing the level of dust, increase work efficiency, and provide a hospitable environment for the tree roots. A range of 50-70% field capacity is generally workable. Apply moisture as needed to reach workable conditions.
 4. The SSAT shall be used by a trained Arborist with documented experience in root pruning and construction utility excavation.
 5. Excavation shall be to maximum 24" depth or equal to depth of adjacent construction grading. Document location and notify construction management.
 6. Should existing underground utilities be discovered do not cut utility. Notify Contractor and Owner to coordinate.
 7. All pruned roots shall be cut with sharpened instrument designed for that purpose such as loppers or hand pruning saws.

8. Temporarily mark location of root prune trench with labeled survey markers for later reference during construction. Backfill root prune trench with excavated soil the same day as opened. Hand tamp soil and do not compact more than 80% to allow ample water penetration and air pressure in upper limits. Hand rake to grade. Haul off excess soil. All root pruning operations shall be directed in the field by an ISA Certified Arborist with documented experience in similar SSAT excavation and root pruning.
- H. Temporary Tree Protection Fence:
1. Type and placement of fence to be designated on shop drawings for approval by the Landscape Architect and The College's arborist.
 2. Attach 18"x18" tree protection area signs @ 50' maximum spacing facing construction Limit of Disturbance (LOD). For fence lower than 6' in height attach minimum 3 strips glow-flagging 2' long for each fence panel.
 3. Tree protection area signs shall be high visibility and all- weather to last the duration of the project / phase. Phone number of responsible point of contact shall be included on sign.
 4. Install after root pruning if shown, and Selective Removals (RBA) inside TPA and prior to clearing & excavation.
 5. Install at 6"-12" outside (construction side) of the Root Prune line or within the Root Prune trench.
 6. Silt fence will be outside (construction side) the tree protection fence unless super- silt fence is used in lieu of tree protection.
 7. Exact placement of fence will be determined in walk through with Contractor, Project Arborist, and the College's arborist.
 8. Sequencing of the tree protection fence will be determined during the initial site walk. In any case no construction activities shall occur in each phase or section until approved protection is installed. Where temporary tree protection fence is shown adjacent major excavations, grading and staging with no super silt fence shown, attach silt fence fabric to tree protection fence using trenchless methods. The purpose is to restrict stockpiled material from sliding or washing thru fence into TPAs.
- I. Heavy Duty Root Aeration Matting (HDRAM)
1. Heavy Duty Root Aeration Matting shall be used in any location within the critical root zone of trees located within Tree Preservation Areas, where fill or paved surfaces will be placed over existing roots. Provide shop drawings indicating layout and details where this method is to be utilized, for review by Landscape Architect and the College's arborist. Mark layout in field for final review by Contractor and the College's arborist. There is to be no compaction of sub-grade, nor excavation prior to installation of the HDRAM.
 2. Install bottom 4 oz geotextile roll, next inner heavy duty extruded rolls, then top 8 oz geotextile. Secure with 12-18" staple or soil nail with washer through all three materials.
 3. No equipment is to operate on RAM without specific experience working with geotextiles and guidance and approval from Certified Arborist.
 4. Installation of stone, compaction, and completion of work shall be monitored by the College's arborist.
- J. Supersonic Airtool SSAT Excavation within TPAs
1. Proposed dry utilities, conduits, wall footers, roadway sections into grade for placement within the TPAs of impact to select tree critical roots zones may be designated for excavation with the Supersonic Airtool (SSAT) in order to minimize damage to root systems.
 2. Provide shop drawings indicating plan location where this method is to be utilized for approval by the Landscape Architect and the College's arborist prior to commencement of this work.

3. The Project Arborist shall provide a qualified arborist crew experienced with the SSAT and utility excavation to protect adjacent natural resources and construction work, open the excavation, hand prune minor roots, and identify and protect priority roots to remain.
4. Do not perform this operation during drought months without adequate supplemental moisture to reach a minimum of 50% field capacity.
5. Protect adjacent trades, vehicles or pedestrians from dust or flying debris.
6. Coordination with the appropriate trade / sub-contractor shall be made as to appropriate width, depth, sequencing, utility installation, backfill, completion, and cover.
7. Supplemental watering by root misting on a daily basis during excess of 80 degree days shall be provided by the Project Arborist for exposed roots. A temporary plastic or equal membrane may be applied over the trench for exposed roots over 24 hour's duration, and then removed prior to backfill.

3.2 ADDITIONAL STRESS REDUCTION MEASURES

- A. In addition to the measures outlined above, trees receiving moderate to high levels of impact, meaning greater than 25% of the critical root zone will be impacted by construction activities, will be required to receive one or more of the following treatments. The Project Arborist shall determine recommendations for employment of any of these methods per specific tree. Shop drawings indicating the plan locations and details for employment of these methods shall be prepared by the Project Arborist for review and approval by the Landscape Architect and the College's arborist.

1. Mulching of Trees:
 - a. For linear TPAs along LOD Install mulch strips a minimum 15' wide the length of critical root zones along the outside of the LOD/ Root Prune line (just inside the Tree Protection Zone) for significant trees (greater than 18 inches dbh) impacted by proposed construction, as determined by Project Arborist.
 - b. Motorized equipment shall not be allowed to enter the TPA unless rubber tracked skid steer or turf tired tractor driving on appropriate matting or mulch.
 - c. Mulch depth shall be 3" unless approved by Architect's Project Forester. Mulch shall not contact trunk or root flare of trees in TPA. Any motorized equipment shall be operated or monitored by a certified arborist while inside the TPA.
2. Plant Growth Regulator (Paclobutrazol): Paclobutrazol Specific methods and dosages are contained on the label and are determined by size and species, and applied by a state licensed pesticide applicator.
3. Supplemental Watering:
 - a. Based upon the number and size of trees various strategies can be considered to maintain adequate soil moisture during these times. These strategies may include but are not limited to the following:
 - 1) Fire hydrant connection battery powered timer and drip irrigation hose / tubing.
 - 2) Water tank trunk and hand applied as directed.
 - 3) Temporary above grade poly tank with battery powered timers for drip or soaker hoses at each TPA.
 - 4) 30-50 gallon watering cans with 6-8 drilled holes in bottom to allow slow seeping of water; spacing and rotation to reach desired gallons. Equivalent means of effectively watering trees as approved by the Architect's Landscape Architect or the College's arborist.

- b. A prescription for the number of gallons and strategy for watering designated trees will be developed by the Project Arborist for approval by the College's arborist. Large mature trees with impacts to root systems require as much as 100- 250 gallons per week during 90 degree days during summer drought times.
 - c. Periodic inspections by an ISA Certified Arborist at this time are critical. Depth of moisture in soils shall be determined by soil sample tube or other exploratory means.
 - d. Minimum watering shall be considered to be 9 applications per growing season typically May thru October with the exact timing and duration to be determined by the ISA Arborist in conjunction with the Landscape Architect.
4. Soil Decompaction / Radial Mulching
- a. Pneumatic de-compaction of soils at designated trees by entrenching radial "spokes" in the upper soils out from the tree trunk using SSAT.
 - b. This work may be also prescribed as "Contingency or Remedial Work" due to unwarranted construction incursion into the protected TPAs.
 - c. The size of the radial mulch trench is generally 12-15" inches deep and 12-15 inches wide, although fracturing of soil layers may extend beyond these dimensions. Generally the inner 1/3 of the critical root zone will receive treatment.
 - d. Cut girdling roots exposed during this operation.
 - e. Do not perform this operation during drought months without adequate supplemental moisture to reach a minimum of 50% field capacity. Apply moisture to designated areas to reach minimum soil capacity.
 - f. Do not dispose of the excavated soils. Dispose of exposed trash or debris encountered. Mark exposed utilities and irrigation lines.
 - g. Backfill each radial mulching trench prior to the end of workday unless approved otherwise by the Owner and the College's arborist.
 - h. Backfill with excavated site soils amended with granular or liquid Humate and 25% compost from a local certified compost facility bulk source - not over the counter commercially available bagged products.
 - i. Hand rake smooth to existing grade and haul off excess
5. Installation of Compost Tea and Humate:
- a. No man made Nitrogen is applied using these standards and materials.
 - b. Initial soil testing was assayed by the Agricultural Service Laboratory. Results and recommendations were reviewed by the Architect's Project Forester to determine specific mix of ingredients for applications.
 - c. Three seasonal applications are timed over each year's growing season. Soil testing after the end of construction during the landscape installation shall be submitted by the Project Arborist.
 - d. Submit number of applications anticipated with Test results that vary from above.
 - e. Applications generally are as follows based upon season, weather, and soils conditions:
 - f. Granular Humate Surface Application.
 - g. Liquid Humate surface spray.
 - h. Liquid Compost Tea inoculants composed of prescribed amounts of beneficial fungi, flagellates, and beneficial nematodes, and bacteria.
 - i. Additional applications of any three above based upon season, weather, and need.
6. Monitor and Treat Health:
- a. An ISA Certified Arborist shall perform monitoring twice per month for six months growing season and once per month for the dormant season to monitor insects, disease, soil moisture levels, weather, and health changes on all trees within Tree Preservation Areas impacted by construction.

- b. The monitoring will include a monthly report that details any problematic areas that have been addressed along with the treatments provided to reduce the problem. This report will be forwarded to the College's arborist for documentation.
 - c. Upon request submit price for requested additional treatments beyond those specified in these documents. Owner shall review and approve additional contingency work. No additional work is to be performed unless approved in writing by the Owner.
 - d. Preventative treatment for destructive insects. Certified Licensed Pesticide applicator shall provide treatments for the following pests for each phase and trees indicated:
 - 1) Emerald ash borer.
 - 2) Two lined chestnut borer.
 - 3) Other boring moths, beetles, wasps, and related boring insects common to the region and species.
 - e. Apply Imidacloprid soil treatments such as Merit, or Onyx or equivalent per label directions.
 - f. Determining if these borers will infest a given tree or group of trees is difficult. While stressed trees are typically the first to be attacked, many of these insects will attack trees that appear to be healthy. Unlike many pests that can be treated when observed, borers can be fatal once their presence is noted. Therefore, preventative pesticide treatments are necessary during the at risk periods. Newly transplanted trees near areas with larger trees in a declining condition are also at risk. As with many borers, once the larvae have entered the trunk or branch, reactive treatments historically are not successful. Timing for preventative treatments will vary with species. Where the borer species is unknown, applications 45-60 days apart will provide coverage during the emergence period. Typical treatments would be on or about June 1, July 1 and August 1.
7. Contingency for Remedial Arboricultural Measures:
- a. Contingency budget may be secured at the Owner's determination for potential remedial arboricultural measures as a result of weather events, large outbreaks of insect and disease, and unforeseen impacts during or after construction is completed for each phase.
 - b. These measures may include but are not limited to:
 - 1) Pruning broken branches.
 - 2) Plant Growth Regulators.
 - 3) Radial Aeration/ Mulching with SSAT for compacted or silted areas.
 - 4) Treatments of compost tea and other approved soil amendments.
 - 5) Treatments of Insect or disease outbreaks.
 - 6) Aerial assessment or invasive testing procedures.

3.3 EXCAVATION

- A. Any grading, construction, demolition, or other work that is expected to encounter tree roots (in the estimation of the College or consulting arborist) must be monitored by the consulting arborist.
- B. Before grading, subgrade preparation, or excavation for foundations, footings, walls, or trenching, impacted trees will be root pruned at the maximum allowable distance from the tree trunk to the disturbed area by cutting all roots cleanly to a depth no less than 18 inches and no more than the area of disturbance adjacent to it. Trenches, at these outermost limits, will be hand dug and/or air spaded to at least 18" deep by 12" wide and a qualified arborist will cut all of the exposed roots (including small feeder roots) with a sharp saw. The trench will then be

promptly backfilled with a damp combination of wood chips, peat moss, terra gel and organic matter.

- C. Install shoring or other protective support systems to minimize sloping or benching of excavations.
- D. Do not excavate within drip line of trees, unless otherwise indicated and with prior approval from the College.
- E. All underground utilities and drain or irrigation lines shall be routed outside the designated tree protection zones. If lines must traverse the protection area, they shall be tunneled or bored under the tree using trenchless excavation techniques, such as directional boring, pipe jacking, moling or horizontal auger boring, and must perform the work in a manner acceptable to the College or designated professional.
- F. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks and comb soil to expose roots.
 - 1. Relocate roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and relocate them without breaking. If encountered immediately adjacent to location of new construction and relocation is not practical, cut roots approximately 3 inches (75 mm) back from new construction.
 - 2. 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.
- G. Where utility trenches are required within drip line of trees, tunnel under or around roots by drilling, auger boring, pipe jacking, or digging by hand.
 - 1. Root Pruning: Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots with sharp pruning instruments; do not break or chop.

3.4 TREE REPAIR AND REPLACEMENT

- A. If injury should occur to any tree during construction, it should immediately be evaluated by the consulting arborist so that appropriate treatments can be applied. The consulting arborist should promptly repair trees damaged by construction operations within 24 hours. The arborist should treat damaged trunks, limbs, as well as roots.
- B. Remove and replace dead and damaged trees as indicated in Project Conditions (item 1.5 D above)
- C. Aerate surface soil, compacted during construction, 10 feet (3 m) beyond drip line and no closer than 36 inches (900 mm) to tree trunk. Drill 3-inch- (50-mm-) diameter holes a minimum of 8 inches (300 mm) deep at 30 inches (600 mm) o.c. Before drilling holes, place 3 ounces PHC Vertimulch and a shovel full of compost in a pile on top of each hole location. Drill directly through the small piles of Vertimulch/compost, mixing with soil by drilling up and down 2 or 3 times. Backfill holes with amended soil mixture.

3.5 TREE CARE

- A. All tree protection zones will be irrigated on a schedule to be determined by the consulting arborist. (Note: Schedule, when determined, will be forthcoming from the university). Each watering shall wet the soil within the tree protection zone to a depth of about 30 inches.

3.6 DISPOSAL OF WASTE MATERIALS

- A. Burning is not permitted.
- B. Disposal: Remove excess excavated material displaced trees of insignificant value in accordance with the Owner's requirements, and excess chips from Owner's property.

END OF SECTION

SECTION 01 6000
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 012500 "Substitution Procedures" for requests for substitutions.
 - 2. Section 014200 "References" for applicable industry standards for products specified.

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. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved by Architect through submittal process 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. 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.
- 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, if applicable.

1.4 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
 - 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Contractor through Construction Manager of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
 - a. Form of Approval: As specified in Section 013300 "Submittal Procedures."
 - b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

1.5 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.
 - 1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 - 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.
- 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-connected 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 identification requirements.

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 to determine that products are undamaged and properly protected.
- C. Storage:
 - 1. Store products to allow for inspection and measurement of quantity or counting of units.
 - 2. Store materials in a manner that will not endanger Project structure.
 - 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 - 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 - 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 - 6. Protect stored products from damage and liquids from freezing.
 - 7. 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 warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 - 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for 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 with the Specifications, 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 not in conflict with 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.
1. Or Equal: For products specified by name and accompanied by the term "or equal," or "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 through Construction Manager in order to establish equivalency of proposed products. 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, which 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: ..."
 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, which 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: ..."
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 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 01 2500 "Substitution Procedures" for substitutions for convenience.
- C. Visual Matching Specification: Where Specifications require "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 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.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration: 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 these requirements:
 1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 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. Submittal Requirements: 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

SECTION 01 7300

EXECUTION

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 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. Coordination of Owner-installed products.
 - 6. Progress cleaning.
 - 7. Starting and adjusting.
 - 8. Protection of installed construction.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for limits on use of Project site.
 - 2. Section 013300 "Submittal Procedures" for submitting surveys.
 - 3. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.
 - 4. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.
 - 5. Section 078413 "Penetration Firestopping" for patching penetrations in fire-rated construction.

1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 PREINSTALLATION MEETINGS

- A. Cutting and Patching Conference: Conduct conference at Project site.
 - 1. Prior to commencing work requiring cutting and patching, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting

and patching work. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:

- a. Contractor's superintendent.
 - b. Trade supervisor responsible for cutting operations.
 - c. Trade supervisor(s) responsible for patching of each type of substrate.
 - d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affecting by cutting and patching operations.
2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For land surveyor.
- B. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.
- C. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
 3. Products: List products to be used for patching and firms or entities that will perform patching work.
 4. Dates: Indicate when cutting and patching will be performed.
 5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
 - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.
- D. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- E. Certified Surveys: Submit two copies signed by land surveyor.
- F. Final Property Survey: Submit 10 copies showing the Work performed and record survey data.

1.6 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. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
 1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut

- and patch structural elements in a manner that could change their load-carrying capacity or increase deflection
2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:
 - a. Primary operational systems and equipment.
 - b. Fire separation assemblies.
 - c. Air or smoke barriers.
 - d. Fire-suppression systems.
 - e. Mechanical systems piping and ducts.
 - f. Control systems.
 - g. Communication systems.
 - h. Fire-detection and -alarm systems.
 - i. Conveying systems.
 - j. Electrical wiring systems.
 - k. Operating systems of special construction.
 3. Other Construction Elements: Do not cut and patch other 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. Other construction elements include but are not limited to the following:
 - a. Water, moisture, or vapor barriers.
 - b. Membranes and flashings.
 - c. Exterior curtain-wall construction.
 - d. Sprayed fire-resistive material.
 - e. Equipment supports.
 - f. Piping, ductwork, vessels, and equipment.
 - g. Noise- and vibration-control elements and systems.
 4. 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.
- C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: 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.

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, 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.
 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 local utility 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 caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to 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. If discrepancies are discovered, notify Architect and Construction Manager promptly.
- B. General: Engage a land surveyor to lay out the Work using 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 and Construction Manager 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 and Construction Manager.

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 or Construction Manager. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect and Construction Manager 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.
 - 2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

- A. General: 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.
- 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 the best possible results. 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.
- 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: Do not use tools or equipment that produce harmful 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 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.
 - 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. Fit exposed connections together to form hairline joints.
- J. Repair or remove and replace damaged, defective, or nonconforming Work.
 - 1. Comply with Section 01 7700 "Closeout Procedures" for repairing or removing and replacing defective Work.
- K. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 CUTTING AND PATCHING

- A. Cutting and Patching, 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 according to 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 prevent 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. 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 minimize 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. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. 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 OWNER-INSTALLED PRODUCTS

- A. Site Access: Provide access to Project site for Owner's construction personnel.
- 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. General: 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 in Finished Areas: 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 assure 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.

END OF SECTION

SECTION 01 7419

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

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. Salvaging nonhazardous demolition waste.
 - 2. Recycling nonhazardous demolition and construction waste.
 - 3. Disposing of nonhazardous demolition and construction waste.
- B. Related Requirements:
 - 1. Section 024119 "Selective Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements.
 - 2. Section 042000 "Unit Masonry" for disposal requirements for masonry waste.
 - 3. Section 311000 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.3 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.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling of 75 percent by weight of total non-hazardous solid waste generated by the Work. 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, including the following:
1. Demolition Waste:
 - a. Asphalt paving.
 - b. Concrete.
 - c. Concrete reinforcing steel.
 - d. Brick.
 - e. Concrete masonry units.
 - f. Wood studs.
 - g. Wood joists.
 - h. Plywood and oriented strand board.
 - i. Wood paneling.
 - j. Wood trim.
 - k. Structural and miscellaneous steel.
 - l. Rough hardware.
 - m. Roofing.
 - n. Insulation.
 - o. Doors and frames.
 - p. Door hardware.
 - q. Windows.
 - r. Glazing.
 - s. Metal studs.
 - t. Gypsum board.
 - u. Acoustical tile and panels.
 - v. Carpet.
 - w. Carpet pad.
 - x. Demountable partitions.
 - y. Equipment.
 - z. Cabinets.
 - aa. Plumbing fixtures.
 - bb. Piping.
 - cc. Supports and hangers.
 - dd. Valves.
 - ee. Sprinklers.
 - ff. Mechanical equipment.
 - gg. Refrigerants.
 - hh. Electrical conduit.
 - ii. Copper wiring.
 - jj. Lighting fixtures.
 - kk. Lamps.
 - ll. Ballasts.
 - mm. Electrical devices.
 - nn. Switchgear and panelboards.
 - oo. Transformers.
 2. Construction Waste:
 - a. Masonry and CMU.
 - b. Lumber.
 - c. Wood sheet materials.
 - d. Wood trim.

- e. Metals.
- f. Roofing.
- g. Insulation.
- h. Carpet and pad.
- i. Gypsum board.
- j. Piping.
- k. Electrical conduit.
- l. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:
 - 1) Paper.
 - 2) Cardboard.
 - 3) Boxes.
 - 4) Plastic sheet and film.
 - 5) Polystyrene packaging.
 - 6) Wood crates.
 - 7) Plastic pails.

1.5 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 30 days of date established for commencement of the Work.

1.6 INFORMATIONAL SUBMITTALS

- A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use Form CWM-7 for construction waste and Form CWM-8 for demolition waste. Include the following information:
 - 1. Material category.
 - 2. Generation point of waste.
 - 3. Total quantity of waste by weight or volume.
 - 4. Quantity of waste salvaged, both estimated and actual by weight or volume.
 - 5. Quantity of waste recycled, both estimated and actual by weight or volume.
 - 6. Total quantity of waste recovered (salvaged plus recycled) by weight or volume.
 - 7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- B. 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.
- C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- E. 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.

- F. 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.
- G. LEED Submittal: LEED letter template for Credit MR 2, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.
- H. Qualification Data: For waste management coordinator and refrigerant recovery technician.
- I. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.7 QUALITY ASSURANCE

- A. Waste Management Coordinator Qualifications: Experienced firm, with a record of successful waste management coordination of projects with similar requirements, that employs a LEED-Accredited Professional, certified by the USGBC, as waste management coordinator. Waste management coordinator may also serve as LEED coordinator.
- B. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
- C. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
- D. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 01 3100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:
 - 1. Review and discuss waste management plan including responsibilities of waste management coordinator.
 - 2. Review requirements for documenting quantities of each type of waste and its disposition.
 - 3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
 - 4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
 - 5. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. 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. Use Form CWM-1 for construction waste and Form CWM-2 for demolition waste. 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. Use Form CWM-3 for construction waste and Form CWM-4 for demolition waste or other approved form. 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.
 - 1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."
- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
 - 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: Salvage items for reuse and handle as follows:
 1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 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: Salvage items for Owner's use and handle as follows:
 1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 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.
- D. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.
- E. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
- F. Plumbing Fixtures: Separate by type and size.
- G. Lighting Fixtures: Separate lamps by type and protect from breakage.
- H. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

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 be shared equally by Owner and Contractor.
- C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

- D. 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 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.
 - 1. Pulverize concrete to maximum 1-1/2-inch (38-mm) size.
- C. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
 - 1. Pulverize masonry to maximum 1-inch (25-mm) size.
 - a. Crush masonry and screen to comply with requirements in Section 329300 "Plants" for use as mineral mulch.
 - 2. 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: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
 - 1. Store clean, dry carpet 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. Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.
- D. Disposal: Remove waste materials and dispose of at designated spoil areas on Owner's property.
- E. Disposal: Remove waste materials from Owner's property and legally dispose of them.

3.7 ATTACHMENTS

- A. Form CWM-1 for construction waste identification.
- B. Form CWM-2 for demolition waste identification.
- C. Form CWM-3 for construction waste reduction work plan.
- D. Form CWM-4 for demolition waste reduction work plan.
- E. Form CWM-7 for construction waste
- F. Form CWM-8 for demolition waste.

END OF SECTION

SECTION 01 7700
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.
 - 5. Repair of the Work.
- B. Related Requirements:
 - 1. Section 013233 "Photographic Documentation" for submitting final completion construction photographic documentation.
 - 2. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 3. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
 - 4. Section 017900 "Demonstration and Training" for requirements for instructing Owner's personnel.

1.3 ACTION SUBMITTALS

- A. Product Data: For cleaning agents.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 CLOSEOUT SUBMITTALS

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

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1.6 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, final completion construction photographic documentation, 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 Architect's signature for receipt of submittals.
 - 5. Submit test/adjust/balance 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 heat and other utilities.
 - 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, including touchup painting.

10. Touch up 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 and Construction Manager 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. Reinspection: 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.

1.7 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 according to 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 and Construction Manager 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. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

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 and proceeding from lowest floor to highest floor.
2. Organize items applying to each space by major element, including categories for ceiling, 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 and Construction Manager.
 - d. Name of Contractor.

- e. Page number.
4. Submit list of incomplete items in the following format:
 - a. PDF electronic file. Architect will return annotated file.
 - b. Web-based project software upload. Utilize software feature for creating and updating list of incomplete items (punch list).

1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, 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.
 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.
 4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
- D. 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, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, 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 neither planted nor 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. Sweep concrete floors broom clean in unoccupied spaces.
 - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 - j. 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.
 - k. Remove labels that are not permanent.
 - l. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - o. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
 - p. 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 before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
 - 1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
 - 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 - 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
 - 4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION

SECTION 01 7823

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 01 3300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
 - 2. Section 01 9113 "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 by uploading to web-based project software site. 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 01 7700 "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.

- 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 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.

1.8 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.
- 1.9 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.
- 1.10 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

SECTION 01 7839

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 017300 "Execution" for final property survey.
 - 2. Section 017700 "Closeout Procedures" for general closeout procedures.
 - 3. 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 copies of record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit PDF electronic files of scanned record prints and one 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 PDF electronic files of scanned record prints and three set(s) of prints.
 - 2) Print each drawing, whether or not changes and additional information were recorded.
 - c. Final Submittal:
 - 1) Submit record digital data files and three set(s) of record digital data file plots.
 - 2) 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.

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 archive 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 below first floor.
 - 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 sets 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 the original Contract Drawings.
 2. Format: Annotated PDF electronic file with comment function enabled.
 3. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 4. Refer instances of uncertainty to Architect through Construction Manager for resolution.
 5. Architect will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.
 - a. See Section 01 3100 "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 and newly prepared record Drawings 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 and Construction Manager.
 - 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. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
 3. 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.

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

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION

SECTION 01 7900

DEMONSTRATION AND TRAINING

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 instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
 - 3. Demonstration and training video recordings.

1.3 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
- B. Qualification Data: For facilitator, instructor, and videographer.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
 - 1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project.
 - b. Name and address of videographer.
 - c. Name of Architect.
 - d. Name of Construction Manager.
 - e. Name of Contractor.

- f. Date of video recording.
2. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
3. At completion of training, submit complete training manual(s) for Owner's use prepared in same PDF file format required for operation and maintenance manuals specified in Section 01 7823 "Operation and Maintenance Data."Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

1.5 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 01 4000 "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.
- D. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 01 3100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
 1. Inspect and discuss locations and other facilities required for instruction.
 2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
 3. Review required content of instruction.
 4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.6 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

1.7 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Systems and equipment operation manuals.
 - c. Systems and equipment maintenance manuals.
 - d. Product maintenance manuals.
 - e. Project Record Documents.
 - f. Identification systems.
 - g. Warranties and bonds.
 - h. Maintenance service agreements and similar continuing commitments
 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
 4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
 5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

1.8 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

1.9 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 1. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 1. Schedule training with Owner, through Construction Manager, with at least seven days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.

- F. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

1.10 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. 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 HD modewith vibration reduction technology.
 - 1. Submit video recordings by uploading to web-based Project software site.
 - 2. File Hierarchy: Organize folder structure and file locations according to Project Manual table of contents. Provide complete screen-based menu.
 - 3. File Names: Utilize file names based on name of equipment generally described in video segment, as identified in Project specifications.
 - 4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the equipment demonstration and training recording that describes the following for each Contractor involved on the Project, arranged according to Project Manual table of contents:
 - a. Name of Contractor/Installer.
 - b. Business address.
 - c. Business phone number.
 - d. Point of contact.
 - e. Email address.
- B. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
 - 1. Film training session(s) in segments not to exceed 15 minutes.
 - a. Produce segments to present a single significant piece of equipment per segment.
 - b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
 - c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.
- C. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
 - 1. Furnish additional portable lighting as required.
- D. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.
- E. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION

SECTION 01 8113

SUSTAINABLE DESIGN REQUIREMENTS

LEED FOR NEW CONSTRUCTION AND MAJOR RENOVATIONS

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 general requirements and procedures for compliance with certain USGBC LEED prerequisites and credits needed for Project to obtain LEED Silver certification based on USGBC's "LEED 2009 for New Construction & Major Renovations."
 - 1. Other 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.
 - 2. A copy of 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 Architect's design and other aspects of Project that are not part of the Work of the Contract.
 - 3. Specific requirements for LEED are included in greater detail in other Sections.
- B. Related Sections:
 - 1. 01 7419 Construction Waste Management and Disposal
 - 2. 01 8116 VOC Limits for Adhesives, Sealants, Paints and Coatings
 - 3. 01 8119 Construction Indoor Air Quality Management
 - 4. 01 9100 Building Commissioning
 - 5. Divisions 01 through 33: LEED requirements specific to the work of each of these Sections. Requirements may or may not include reference to LEED.

1.3 DEFINITIONS

- A. Chain-of-Custody Certificates: Certificates signed by manufacturers 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, "FSC Principles and Criteria for Forest Stewardship." Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
- B. LEED: Leadership in Energy & Environmental Design.

- C. Rapidly Renewable Materials: Materials made from plants that are typically harvested within a 10-year or shorter cycle. Rapidly renewable materials include products made from bamboo, cotton, flax, jute, straw, sunflower seed hulls, vegetable oils, or wool.
- D. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.
- E. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.
 - 1. "Post-consumer" 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. "Pre-consumer" 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.
 - 3. Spills and scraps from the original manufacturing process that are combined with other constituents after a minimal amount of reprocessing for use in further production of the same product are not recycled materials.
 - 4. Discarded materials from one manufacturing process that are used as constituents in another manufacturing process are pre-consumer recycled materials.
- F. Inside the Building: Defined as inside the weatherproofing system.
- G. Bio-Based Materials: One of the following:
 - 1. Materials with bio-based content of not less than 75 percent when tested according to ASTM D 6866.
 - 2. Wood and wood products that are labeled in accordance with the American Forest & Paper Association's Sustainable Forestry Initiative.
 - 3. Wood and wood products that are certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004.
 - 4. Wood and wood products that are certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.
 - 5. Salvaged or reused wood products.
 - 6. Materials that comply with 7 CFR 3202.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site. Review LEED requirements and action plans for complying with requirements.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Respond to questions and requests from Architect and the USGBC regarding LEED credits that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until the USGBC has made its determination on the project's LEED certification application. Document responses as informational submittals.
- B. Submit documentation to USGBC and respond to questions and requests from USGBC about LEED prerequisites and credits that are the responsibility of the Contractor, that depend on

product selection or product qualities, or that depend on Contractor's procedures until USGBC has made its determination on Project's LEED certification application.

1. Document correspondence with USGBC as informational submittals.

C. LEED Coordination Conference: Schedule a LEED coordination conference before starting construction, at a time convenient to Owner, Architect, and Commissioning Agent.

1. Agenda: Discuss items of significance that could affect complying with requirements for LEED certification, including the following:
 - a. LEED Project Checklist.
 - b. General requirements for LEED-related procurement and documentation.
 - c. Project closeout requirements and LEED certification procedures.
 - d. Role of LEED coordinator.
 - e. Construction waste management.
 - f. Construction operations and LEED requirements and restrictions.

1.6 LEED REQUIREMENTS

- A. The table below summarizes the LEED prerequisites and points targeted to be achieved and identifies where specific requirements to meet LEED criteria are addressed in the technical specifications and general conditions. Where the reference indicates "Design", the points are provided through the Architect's design and Owners programming requirements which shall not be modified or omitted without prior approval of the Architect.

LEED Prerequisites and Points		Design/Specification Sections
<i>Sustainable Sites (SS)</i>		
SSp1	Construction Activity Pollution Prevention	Design
SSc1	Site Selection	Design
SSc2	Development Density and Community Connectivity	Design
SSc4.2	Alternative Transportation-Bicycle Storage and Changing Rooms	Design
SSc4.3	Alternative Transportation-Low-Emitting and Fuel-Efficient Vehicles	Design
SSc4.4	Alternative Transportation-Parking Capacity	Design
SSc5.1	Site Development-Protect or Restore Habitat	Design
SSc5.2	Site Development-Maximize Open Space	Design
SSc6.1	Stormwater Design-Quantity Control	Design
SSc6.2	Stormwater Design-Quality Control	Design
SSc7.1	Heat Island Effect-Non Roof	Design

SSc8	Light Pollution Reduction	Design
Water Efficiency (WE)		
WEp1	Water Use Reduction-20%	Design
WEc1	Water Efficient Landscaping – No Potable Water	Design
WEc3	Water Use Reduction - 35%	Design
Energy and Atmosphere (EA)		
EAp1	Fundamental Commissioning of Building Energy Systems	Design/Divisions 22, 23, 26
EAp2	Minimum Energy Performance	Design/Divisions 23, 26
EAp3	Fundamental Refrigerant Management	Design/Divisions 23
EAc1	Optimize Energy Performance	Design/Divisions 23, 26
EAc3	Enhanced Commissioning	Design/Divisions 1, 22, 23, 26
EAc4	Enhanced Refrigerant Management	Design/Divisions 1, 22, 23
EAc6	Green Power	Design
Materials and Resources (MR)		
MRp1	Storage and Collection of Recyclables	Design
MRc1	Building Reuse	Design/ See Specifications
MRc2	Construction Waste Management (75%+)	017419
MRc3	Materials Reuse	Design/ See Specifications
MRc4	Recycled Content (20%)	See Specifications
MRc5	Regional Materials (20%)	See Specifications
MRc7	Certified Wood	See Specifications
Indoor Environmental Quality (IEQ)		
IEQp1	Minimum Indoor Air Quality Performance	Design
IEQp2	Environmental Tobacco Smoke (ETS) Control	Design
IEQc1	Outdoor Air Delivery Monitoring	Design/Division 23

IEQc3.1	Construction IAQ Management Plan-During Construction	011819
IEQc3.2	Construction IAQ Management Plan-Before Occupancy	011819
IEQc4.1	Low Emitting Materials-Adhesives and Sealants	See Specifications
IEQc4.2	Low Emitting Materials-Paints and Coatings	See Specifications
IEQc4.3	Low Emitting Materials-Flooring Systems	Design
IEQc4.4	Low Emitting Materials-Composite Wood	See Specifications
IEQc5	Indoor Chemical and Pollutant Source Control	Design/Division 23
IEQc6.1	Controllability of Systems-Lighting	Design/Division 23
IEQc6.2	Controllability of Systems-Thermal Comfort	Design/Division 23
IEQc7.1	Thermal Comfort-Design	Design/Divisions 23, 26
IEQc7.2	Thermal Comfort-Verification	Design/Divisions 23, 26
IEQc8.1	Daylight & Views: Daylight 75% of Spaces	Design
IEQc8.2	Daylight & Views: Views 90% of Spaces	Design
<i>Innovation in Design (ID)</i>		
IDc1.1	Innovation in Design: Exemplary Performance Recycled Content	Design
IDc1.2	Innovation in Design: Exemplary Performance Green Power	Design
IDc1.3	Innovation in Design: Integrated Pest Management	Design
IDc1.4	Innovation in Design: Education Program	Design
IDc1.5	Innovation in Design: Green Cleaning Program	Design
IDc2	LEED Accredited Professional	Design

1.7 ACTION SUBMITTALS

- A. General: Submit additional LEED submittals required by other Specification Sections.
- B. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
- C. Project Materials Cost Data:
 - 1. A detailed construction budget with labor & material breakdown from the Contractor is required to calculate the Project's compliance with LEED Materials and Resources Credits.
 - 2. Contractor shall provide a detailed cost breakout from each subcontractor, indicating total cost for materials. Costs should exclude labor, overhead, and profit and should be provided for the following categories of items:
 - a. Divisions 03-10
 - b. Division 31: Foundations (31 60 00)
 - c. Division 32: Paving (32 10 00), Site Improvements (32 30 00), Planting (32 90 00)
- D. LEED Documentation Submittals:
 - 1. Credit SS 7.2: Product data indicating the reflectivity, emissivity, and solar reflective index (SRI) for all roofing materials.
 - 2. Credit EA 5: Product data and wiring diagrams for sensors and data collection system used to provide continuous metering of building energy-consumption performance over a period of time of not less than one year of postconstruction occupancy.
 - 3. Credit MR 2: Comply with Section 017419 "Construction Waste Management and Disposal."
 - 4. Credit MR 3: Receipts for salvaged and refurbished materials used for Project, indicating sources and costs for salvaged and refurbished materials.
 - 5. Credit MR 4: Product data and certification letter from product manufacturers indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating material cost for each product having recycled content.
 - 6. Credit MR 5: Product data for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
 - 7. Credit MR 7: Product data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
 - 8. Credit IEQ 3.1:
 - a. Construction indoor-air-quality management plan.
 - b. Product data for temporary filtration media.
 - c. Product data for filtration media used during occupancy.
 - d. Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor-air-quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.
 - 9. Credit IEQ 3.2:
 - a. Signed statement describing the building air flush-out procedures including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
 - b. Product data for filtration media used during flush-out and during occupancy.

- c. Report from testing and inspecting agency indicating results of indoor-air-quality testing and documentation showing compliance with indoor-air-quality testing procedures and requirements.
 10. Credit IEQ 4.1: Product data for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used.
 11. Credit IEQ 4.2: Product data for paints and coatings used inside the weatherproofing system indicating VOC content of each product used.
 12. Credit IEQ 4.4: Product data for products containing composite wood or agrifiber products or wood glues indicating that they do not contain urea-formaldehyde resin.
 13. Prerequisite WE 1 and Credit WE 3: Product data indicating plumbing fixture flow rates for all installed plumbing fixtures.
 14. Credit IEQ 5: Product data for MERV 13 filtration media installed prior to occupancy.
- E. LEED Construction Progress Updates: Submit the “*LEED Construction Tracker*” and supporting documentation matching the claims identified within the tracker to LEED Consultant each month via email/file upload:
1. The “*LEED Construction Tracker*” contains the following spreadsheets and must be filled out based on product data submittals and activities of the project:
 - a. Erosion & Sediment Control Photo Documentation Log: This spreadsheet identifies the Erosion and Sediment Control measures implemented onsite and logs when specific photos were taken.
 - b. Construction Waste Management Data Tracker: This spreadsheet contains/computes the raw demolition/construction waste data hauled off the project site.
 - c. Materials Tracker – A. Baseline Establishment: This spreadsheet is used to identify the Total Materials Cost (MR Baseline) for the Materials and Resources LEED Credits.
 - d. Materials Tracker – B. Inputs: This spreadsheet is used to identify the products/materials used on the project and their contributions towards earning the Materials and Resources LEED Credits.
 - e. Indoor Air Quality Photo Documentation Log: This spreadsheet identifies the IAQ measures implemented onsite and logs when specific photos were taken.
 - f. VOC Products: This spreadsheet is used to identify the adhesives/sealants & paints/coatings used on the project. It provides compliance guidance for the requirements of the LEED Low Emitting Materials Credits.
 - g. Flooring and Composite/Aggrifiber Products: This spreadsheet is used to identify the carpets, carpet cushions, flooring systems and composite/aggrifiber products used on the project. It provides compliance guidance for the requirements of the LEED Low Emitting Materials Credits.
 2. Supporting documentation matching the information identified within the “*LEED Construction Tracker*” must be sent to LEED Consultant on a monthly basis via email/file upload. The supporting documents are to be provided in 5 separate files and are as follows:
 - a. SSp1 - E&S Photos: Photo documentation complying with the Erosion and Sediment Control Plan. Photo documentation of installed provisions is to be provided at 3 different times (15 each).
 - b. Materials and Resources Product Inputs:
 - 1) Credit MR 4: Recycled content manufacturer’s product data.
 - 2) Credit MR 5: Regional materials manufacturer’s product data.
 - 3) Credit MR 6: Rapidly renewable manufacturer’s product data.
 - 4) Credit MR 7: Certified wood invoices.

- c. IEQc3.1 – Construction Indoor Air Quality Mgt. Photos: Photo documentation complying with the requirements of with Section 01 18 19 “Construction IAQ Management”. Photo documentation of installed provisions is to be provided at 3 different times (15 each).
- d. IEQc4.1 & 4.2 – Adhesives/Sealants & Paints/Coatings manufacturer’s product data.
- e. IEQc4.3 & 4.4 – Carpet/Flooring Systems & Composite/Agrifiber Wood manufacturer’s product data.

1.8 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 breakout of costs for the following categories of items:
 - 1. Furniture.
 - 2. Plumbing.
 - 3. Mechanical.
 - 4. Electrical.
 - 5. Specialty items such as elevators and equipment.
 - 6. Wood-based construction materials.
- 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. Prerequisite SS 1: Erosion and Sediment Control plan
 - 2. Prerequisite EA 1 and Credit EA 3: Identification of contractor and sub contractor representatives that will act as liaisons and points of contact for Commissioning Agent.
 - 3. Credit MR 2: Waste management plan complying with Section 017419 "Construction Waste Management and Disposal."
 - 4. Credit MR 4: List of proposed materials with recycled content. Indicate cost, post-consumer recycled content, and pre-consumer recycled content for each product having recycled content.
 - 5. Credit MR 5: List of proposed regional materials. Identify each regional material, including its source, cost, and the fraction by weight that is considered regional.
 - 6. Credit MR 7: List of proposed certified wood products. Indicate each product containing certified wood, including its source and cost of certified wood products.
 - 7. Credit IEQ 3.1: Construction indoor-air-quality management plan.
- D. Sustainable Design Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with sustainable design action plans.
- E. LEED Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with LEED action plans for the following:
 - 1. Erosion & Sediment Control Photo Documentation Log: This spreadsheet identifies the Erosion and Sediment Control measures implemented onsite and logs when specific photos were taken
 - 2. Credit MR 2: Waste reduction progress reports complying with Section 017419 "Construction Waste Management and Disposal."

3. Materials Tracker – A. Baseline Establishment: This spreadsheet is used to identify the Total Materials Cost (MR Baseline) for the Materials and Resources LEED Credits.
4. Materials Tracker – B. Inputs: This spreadsheet is used to identify the products/materials used on the project and their contributions towards earning the Materials and Resources LEED Credits.
 - a. Credit MR 4: Recycled content.
 - b. Credit MR 5: Regional materials.
 - c. Credit MR 7: Certified wood products.
5. VOC Products: This spreadsheet is used to identify the adhesives/sealants & paints/coatings used on the project. It provides compliance guidance for the requirements of the LEED Low Emitting Materials Credits.
6. Flooring and Composite Products: This spreadsheet is used to identify the carpets, carpet cushions, flooring systems and composite products used on the project. It provides compliance guidance for the requirements of the LEED Low Emitting Materials Credits.

1.9 QUALITY ASSURANCE

- A. LEED Coordinator: Engage an experienced LEED-Accredited Professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.

PART 2 - PRODUCTS

2.1 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.

2.2 RECYCLED CONTENT OF MATERIALS

- A. Credit MR 4: Building materials shall have recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content for Project constitutes a minimum of 20 percent of cost of materials used for Project.
 1. Cost of post-consumer recycled content plus one-half of pre-consumer recycled content of an item shall be determined by dividing weight of post-consumer recycled content plus one-half of pre-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
 2. Do not include plumbing, mechanical and electrical components, and specialty items such as elevators and equipment in the calculation.

2.3 REGIONAL MATERIALS

- A. Credit MR 5: Not less than 20 percent of building materials (by cost) shall be regional materials.
 1. If regional content product is part of an assembly, indicate relative dollar value of regional content product to total dollar value of assembly.

2. Where product components are sourced or manufactured in separate locations, provide location information for each component.
3. If only a portion of a product or material is extracted, harvested, or recovered and manufactured locally, then only that percentage by weight contributes to the regional value

2.4 CERTIFIED WOOD

- A. Credit MR 7: Not less than 50 percent (by cost) of wood-based materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
 1. 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.
 - n. Furniture.

2.5 LOW-EMITTING MATERIALS

- A. Credit IEQ 4.1: For field applications that are inside the weatherproofing system, adhesives and sealants shall comply with the following VOC content limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 1. Wood Glues: 30 g/L.
 2. Metal-to-Metal Adhesives: 30 g/L.
 3. Adhesives for Porous Materials (Except Wood): 50 g/L.
 4. Subfloor Adhesives: 50 g/L.
 5. Plastic Foam Adhesives: 50 g/L.
 6. Carpet Adhesives: 50 g/L.
 7. Carpet Pad Adhesives: 50 g/L.
 8. VCT and Asphalt Tile Adhesives: 50 g/L.
 9. Cove Base Adhesives: 50 g/L.
 10. Gypsum Board and Panel Adhesives: 50 g/L.
 11. Rubber Floor Adhesives: 60 g/L.
 12. Ceramic Tile Adhesives: 65 g/L.
 13. Multipurpose Construction Adhesives: 70 g/L.
 14. Fiberglass Adhesives: 80 g/L.
 15. Contact Adhesive: 80 g/L.
 16. Structural Glazing Adhesives: 100 g/L.
 17. Wood Flooring Adhesive: 100 g/L.
 18. Structural Wood Member Adhesive: 140 g/L.
 19. Single-Ply Roof Membrane Adhesive: 250 g/L.

20. Special-Purpose Contact Adhesive (contact adhesive that is used to bond melamine-covered board, metal, unsupported vinyl, rubber, or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
 21. Top and Trim Adhesive: 250 g/L.
 22. Plastic Cement Welding Compounds: 250 g/L.
 23. ABS Welding Compounds: 325 g/L.
 24. CPVC Welding Compounds: 490 g/L.
 25. PVC Welding Compounds: 510 g/L.
 26. Adhesive Primer for Plastic: 550 g/L.
 27. Sheet-Applied Rubber Lining Adhesive: 850 g/L.
 28. Aerosol Adhesive, General-Purpose Mist Spray: 65 percent by weight.
 29. Aerosol Adhesive, General-Purpose Web Spray: 55 percent by weight.
 30. Special-Purpose Aerosol Adhesive (All Types): 70 percent by weight.
 31. Other Adhesives: 250 g/L.
 32. Architectural Sealants: 250 g/L.
 33. Nonmembrane Roof Sealants: 300 g/L.
 34. Single-Ply Roof Membrane Sealants: 450 g/L.
 35. Other Sealants: 420 g/L.
 36. Sealant Primers for Nonporous Substrates: 250 g/L.
 37. Sealant Primers for Porous Substrates: 775 g/L.
 38. Modified Bituminous Sealant Primers: 500 g/L.
 39. Other Sealant Primers: 750 g/L.
- B. Credit IEQ 4.2: For field applications that are inside the weatherproofing system, paints and coatings shall comply with the following VOC content limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Flat Paints and Coatings: VOC not more than 50 g/L.
 2. Nonflat Paints and Coatings: VOC not more than 150 g/L.
 3. Dry-Fog Coatings: VOC not more than 400 g/L.
 4. Primers, Sealers, and Undercoaters: VOC not more than 200 g/L.
 5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
 6. Zinc-Rich Industrial Maintenance Primers: VOC not more than 340 g/L.
 7. Pretreatment Wash Primers: VOC not more than 420 g/L.
 8. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
 9. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
 10. Floor Coatings: VOC not more than 100 g/L.
 11. Shellacs, Clear: VOC not more than 730 g/L.
 12. Shellacs, Pigmented: VOC not more than 550 g/L.
 13. Stains: VOC not more than 250 g/L.
 14. Aromatic Compounds: Paints and coating shall not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
 15. Restricted Components: Paints and coatings shall not contain any of the following:
 - a. Acrolein
 - b. Acrylonitrile
 - c. Antimony
 - d. Benzene
 - e. Butyl Benzul phthalate
 - f. Cadmium
 - g. Di (2-ethylexyl) phthalate
 - h. Di-n-butyl phthalate
 - i. Di-n-octyl phthalate
 - j. 1,2-dichlorobenzene
 - k. Diethyl phthalate

- l. Ethylbenzene
- m. Formaldehyde
- n. Hexavalent chromium
- o. Isophorone
- p. Lead
- q. Mercury
- r. Methyl ethyl ketone
- s. Methyl isobutyl ketone
- t. Methylene chloride
- u. Naphthalene
- v. Toluene (methylbenzene)
- w. 1,1,1-trichloroethane
- x. Vinyl chloride

- C. Credit IEQ 4.4: Composite wood, agrifiber products, and adhesives shall not contain urea-formaldehyde resin.

PART 3 - EXECUTION

3.1 NONSMOKING BUILDING

- A. Smoking is not permitted within the building or within **25 feet (8 m)** of entrances, operable windows, or outdoor-air intakes.

3.2 REFRIGERANT AND CLEAN-AGENT FIRE-EXTINGUISHING-AGENT REMOVAL

- A. Prerequisite EA 3: Remove CFC-based refrigerants according to Section 024119 "Selective Demolition" from existing HVAC&R equipment indicated to remain and replace with refrigerants that are not CFC based. Replace or adjust existing equipment to accommodate new refrigerant as described in HVAC Sections.
 - 1. Removal shall be per EPA guidelines and in compliance with the Clean Air Act of 1990 and all final regulations.
 - 2. All work done shall be done by an EPA certified technician using equipment meeting current EPA standards.
 - 3. Refrigerant recycling is mandatory. Owner has right to claim certain quantities per EPA guidelines and must be offered any removed refrigerant first. If Owner refuses refrigerant, technician to provide copies of 'Refrigerant Reclaimer' to the Contractor and the Owner.
- B. Credit EA 4: Remove clean-agent fire-extinguishing agents that contain HCFCs or halons and replace with agent that does not contain HCFCs or halons. See Section 212200 "Clean-Agent Fire-Extinguishing Systems" for additional requirements.

3.3 MEASUREMENT AND VERIFICATION

- A. Credit EA 5: Implement measurement and verification plan consistent with Option B: Energy Conservation Measure Isolation in the EVO's "International Performance Measurement and Verification Protocol (IPMVP), Volume III: Concepts and Options for Determining Energy Savings in New Construction."

- B. If not already in place, install metering equipment to measure energy usage. Monitor, record, and trend log measurements.
- C. Evaluate energy performance and efficiency by comparing actual to predicted performance.
- D. Measurement and verification period shall cover at least one year of postconstruction occupancy.

3.4 CONSTRUCTION WASTE MANAGEMENT

- A. Credit MR 2: Comply with Section 017419 "Construction Waste Management and Disposal."

3.5 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT

- A. Credit IEQ 3.1: Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."
 - 1. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Section 015000 "Temporary Facilities and Controls," install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
 - 2. Replace all air filters immediately prior to occupancy.

3.6 INDOOR-AIR-QUALITY ASSESSMENT

- A. Flush-Out: Credit IEQ 3.2: Comply with one of the following requirements:
 - 1. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of **14000 cu. ft. (4 300 000 L)** of outdoor air per **sq. ft. (sq. m)** of floor area while maintaining an internal temperature of at least **60 deg F (16 deg C)** and a relative humidity no higher than 60 percent.
 - 2. Option 1: If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of **3500 cu. ft. (1 070 000 L)** of outdoor air per **sq. ft. (sq. m)** of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of **0.30 cfm per sq. ft. (1.52 L/s per sq. m)** of outside air or the design minimum outside air rate determined in Prerequisite IEQ 1, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of **14000 cu. ft./sq. ft. (4 300 000 L/sq. m)** of outside air has been delivered to the space.
 - 3. Option 2: Air-Quality Testing: Engage testing agency to perform the following:
 - a. Conduct baseline indoor-air-quality testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air," and as additionally detailed in the USGBC's "Green Building Design and Construction Reference Guide."
 - b. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:
 - 1) Formaldehyde: 27 ppb.
 - 2) Particulates (PM10): 50 micrograms/cu. m.
 - 3) Total Volatile Organic Compounds (TVOC): 500 micrograms/cu. m.
 - 4) 4-Phenylcyclohexene (4-PH): 6.5 micrograms/cu. m.
 - 5) Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.

- c. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from same locations as in the first test.
- d. Air-sample testing shall be conducted as follows:
 - 1) All measurements shall be conducted prior to occupancy but during normal occupied hours, and with building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.
 - 2) Building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Nonfixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.
 - 3) Number of sampling locations varies depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq. ft. (2300 sq. m) or for each contiguous floor area, whichever is larger, and shall include areas with the least ventilation and greatest presumed source strength.
 - 4) Air samples shall be collected between 3 and 6 feet (0.9 and 1.8 m) from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.

END OF SECTION

SECTION 01 8116

VOC LIMITS FOR ADHESIVES, SEALANTS, PAINTS, AND COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes requirements for volatile organic compound (VOC) limits for adhesives sealants, paints and coatings used for the Project, in compliance with the LEED-NCv2009 rating system.
- B. Related Sections:
 - 1. Section 018113: "Sustainable Design Requirements"
 - 2. All technical sections in the specifications which indicate adhesive, sealant, paint, or coating applications.

1.2 REFERENCE STANDARDS

- A. General: Comply with the applicable provisions of the referenced standards except as modified by governing codes and the Contract Documents. Where a recommendation or suggestion occurs in the referenced standards, such recommendation or suggestion shall be considered mandatory. In the event of conflict of referenced standards and this specification or within the standards themselves, the more stringent standard or requirement shall govern.
 - 1. Rule 1168 - "Adhesive and Sealant Applications", amended January 7, 2005): South Coast Air Quality Management District (SCAQMD), State of California, www.aqmd.gov
 - 2. Rule 1113 - "Architectural Coatings": South Coast Air Quality Management District (SCAQMD), State of California, www.aqmd.gov
 - 3. Green Seal Paint Standard GS-11, Green Seal, Inc., Washington, DC.
 - 4. Green Seal Anti-Corrosive Paint Standard GS-03, Green Seal, Inc., Washington, DC
 - 5. Green Seal Commercial Adhesive Standard GS-36, Green Seal, Inc., Washington, DC

1.3 SUBMITTALS

- A. MSDS or manufacturer's technical information for all interior applied adhesives, sealants, paints and coatings, indicating VOC content in grams/Liter (g/L).
- B. Documentation providing the quantity of each adhesive, sealant, paint, and coating product type used on the Project.

PART 2 - PRODUCTS

2.1 INTERIOR ADHESIVES

- A. VOC Limits

1. The volatile organic compound (VOC) content of all field-applied adhesives, adhesive bonding primers, and adhesive primers used on the interior of this Project shall not exceed the limits defined in Rule 1168 - "Adhesive and Sealant Applications" of the South Coast Air Quality Management District (SCAQMD), of the State of California, effective July 1, 2005 with a rule amendment date of January 7, 2005.
2. The VOC limits defined by SCAQMD are measured in grams per liter (g/L), less water and less exempt compounds.
3. General: For specified building construction related applications, the allowable VOC content is as follows:
 - a. Architectural Applications:

1) Indoor carpet adhesive	50
2) Carpet Pad Adhesive	50
3) Wood Flooring Adhesive	100
4) Rubber Floor Adhesive	60
5) Subfloor adhesive	50
6) Ceramic Tile Adhesive	65
7) VCT and asphalt tile adhesive	50
8) Drywall and panel adhesive	50
9) Cove base adhesive	50
10) Multipurpose construction adhesive	70
11) Structural glazing adhesive	100
 - b. Specialty Applications:

1) PVC welding	510
2) CPVC welding	490
3) ABS welding	325
4) Plastic cement welding	250
5) Adhesive primer for plastic	550
6) Contact Adhesive	80
7) Special Purpose Contact Adhesive	250
8) Adhesive Primer for Traffic Marking Tape	150
9) Structural Wood Member Adhesive	140
10) Sheet Applied Rubber Lining Operations	850
11) Top and trim adhesive	540
 - c. Substrate Specific Applications:

1) Metal to metal	30
2) Plastic foams	50
3) Porous material (except wood)	50
4) Wood	30
5) Fiberglass	80

2.2 INTERIOR AEROSOL ADHESIVES

A. VOC Limits

1. The volatile organic compound (VOC) content of all field-applied aerosol adhesives, used on the interior of this Project shall not exceed the limits defined in the Green Seal standard GS-36, Commercial Adhesives, October 19, 2000. Product specific requirements are as follows:
 - a. Aerosol Adhesives

1) General purpose mist spray	65% VOCs by weight
2) General purpose web spray	55% VOCs by weight
3) Special purpose aerosol adhesives	70% VOCs by weight

2.3 INTERIOR SEALANTS

A. VOC Limits

1. The volatile organic compound (VOC) content of all field-applied adhesives, adhesive bonding primers, and adhesive primers used on the interior of this Project shall not exceed the limits defined in Rule 1168 - "Adhesive and Sealant Applications" of the South Coast Air Quality Management District (SCAQMD), of the State of California.
2. The VOC limits defined by SCAQMD are as follows. All VOC limits are defined in grams per liter, less water and less exempt compounds.
3. General: For specified building construction related applications, the allowable VOC content is as follows:
 - a. Sealants:

1) Architectural	250
2) Other	420
 - b. Sealant Primer:

1) Architectural - Nonporous	250
2) Architectural- Porous	775
3) Other	750

2.4 INTERIOR ARCHITECTURAL PAINTS

A. VOC Limits

1. The volatile organic compound (VOC) content of all field-applied architectural paints, used on the interior walls and ceilings of this Project shall not exceed the limits defined in the Green Seal standard GS-11, Paints, 1st Edition, May 20, 1993. Product specific requirements are as follows:
 - a. Paints

1) Flat	50
2) Non-Flat	150
 - b. Primers

1) Flat	50
2) Non-Flat	150

2.5 INTERIOR ANTI-CORROSIVE/ANTI-RUST PAINTS

A. VOC Limits

1. The volatile organic compound (VOC) content of all field-applied anti-corrosive/anti-rust paints, used on the interior of this Project shall not exceed the limits defined in the Green Seal standard GS-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997. Product specific requirements are as follows:
 - a. Anti-corrosive/Anti-Rust Paints

1) Flat	250
2) Non-Flat	250

2.6 INTERIOR COATINGS

A. VOC Limits

1. The volatile organic compound (VOC) content of all field-applied coating used on the interior of this Project shall not exceed the limits defined in Rule 1113 - "Architectural

Coatings" of the South Coast Air Quality Management District (SCAQMD), of the State of California, effective January 1, 2004.

2. The VOC limits defined by SCAQMD are measured in grams per liter (g/L), less water and less exempt compounds.
3. General: For specified building construction related applications, the allowable VOC content is as follows:
 - a. Coatings
 - 1) Clear Wood Finish:
 - a) Varnish 350
 - b) Sanding Sealers 350
 - c) Lacquer 550
 - 2) Clear Brushing Lacquer 680
 - 3) Concrete-Curing Compounds 350
 - 4) Floor Coatings 100
 - 5) Japans/Faux Finishing Coatings 350
 - 6) Low-solids Coatings 120*
 - 7) Magnesite Cement Coatings 450
 - 8) Pigmented Lacquer 550
 - 9) Sealers and Undercoaters 200
 - 10) Shellac
 - a) Clear 730
 - b) Pigmented 550
 - 11) Stains 250
 - 12) Waterproofing Sealers 250
 - 13) Waterproofing Concrete/Masonry Sealers 400
 - 14) Wood Preservatives 350

*Note: VOC levels for Low-Solids coatings are measured in grams of VOC per liter of material, including water.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 8119

CONSTRUCTION INDOOR AIR QUALITY MANAGEMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes general requirements and procedures for compliance with USGBC LEED Credits IEQ 3.1 and IEQ 3.2 under the LEED-NCv2009 rating system.
- B. Several control measures will be necessary to maintain good indoor air quality during construction. The control measures required in this project are described below.
- C. This specification addresses and requires the protection of the ventilation system components during construction and cleanup of contaminated components after construction is complete.
- D. These construction-related Indoor Air Quality procedures shall be included in the pre-construction and construction progress meeting agendas. In addition, the plan will require temporary ventilation in the General Conditions of the construction contract and ensure that all participants in the construction process are aware of the Indoor Air Quality procedures and understand the importance of the goals of the Indoor Air Quality Management Plan
- E. The SMACNA Guidelines recommend control measures in five areas:
 - 1. HVAC protection
 - 2. Source control
 - 3. Pathway interruption
 - 4. Housekeeping
 - 5. Scheduling
- F. Related Sections:
 - 1. Section 018113, "Sustainable Design Requirements."

1.2 REFERENCE STANDARDS

- A. Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings Under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008 (Chapter 3).

1.3 SUBMITTALS

- A. Credit IEQ 3.1:
 - 1. Construction indoor air quality management plan.
 - 2. Product data for MERV 8 temporary filtration media.

3. Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor air quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.

B. Credit IEQ 3.2:

1. Signed statement describing the building air flush-out procedures including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
2. Product data for filtration media used during flush-out and during occupancy.
3. Report from testing and inspecting agency indicating results of indoor air quality testing and documentation showing compliance with indoor air quality testing procedures and requirements.

PART 2 - PRODUCTS

2.1 FILTERS

- A. Return side filters shall be MERV 8 filter performance (ASHRAE 52.2: 35% dust spot and 90% arrestance) or better.
- B. Central filtration (at air handling units) shall be no less than MERV 8 during construction and replaced with not less than MERV 13 filter performance (ASHRAE 52.2: 85% dust spot and >96% arrestance) or better post construction and pre-occupancy.

PART 3 - EXECUTION

3.1 HVAC PROTECTION

- A. All HVAC equipment must be protected from collecting dust and odors during the construction process. The following measures shall be utilized to protect the HVAC equipment and air distribution systems.
- B. Return Side
 1. The return side of the HVAC system (which is by definition ductwork under negative pressure) shall be shut down whenever possible during heavy construction or demolition. The return side shall also be isolated from the surrounding environment as much as possible (e.g., replace all tiles for the ceiling plenum, repair all duct and air handler leaks) and shall be fitted with temporary filters if the system must remain operational during construction. The return side shall have the heaviest work areas dampered off and return system openings shall be sealed with plastic.
- C. Central Filtration
 1. In areas where major dust loading is expected to impact operating HVAC systems that serve areas on the building that were affected by the construction process, install new clean media just prior to substantial completion and occupancy.

D. Supply Side

1. Where possible the supply system or branch serving the construction area should be shut off or dampered off and supply diffusers sealed in plastic. At the completion of construction prior to occupancy the contractor shall observe diffusers for deposited particulates. Clean discharge diffuser dust prior to occupancy and restore the supply side branch operation.

E. Equipment Protection

1. HVAC equipment and components (such as air handlers and return fan units) that are to be installed or that are moth balled during the construction process shall be protected from dust contamination. Entire units and their inlet and discharge openings shall be protected by plastic during the construction process when stored in areas that can be contaminated by construction odor and dust.

F. Duct Cleaning

1. If the systems exposed to construction and dust and/or motor contamination become contaminated due to inadequate protection during construction, the ducts and associated equipment should be thoroughly cleaned after construction and prior to occupancy.

3.2 SOURCE CONTROL

A. Many activities during the construction process produce odor, dust, and particulates.

B. Dust is produced during the following activities:

1. Cutting materials,
2. Drilling materials
3. Sawing materials
4. Sanding materials
5. Rasping materials

C. Combustion products and particulates are produced during the following activities:

1. Welding
2. Cutting with torches
3. Sawing with chain saws
4. Heating with temporary heaters
5. Soldering

D. Volatile organic compounds (VOCs) are produced during the following activities:

1. Painting
2. Cleaning solvent applications
3. Varnish and other coating applications
4. Adhesive applications

E. When conducting these activities during the construction process, source control and pathway interruption isolation strategies shall be used to isolate, minimize, and reduce the introduction of particulates, odors, and VOCs in the construction space. Whenever possible, cutting, drilling, sawing, and sanding should be conducted out of doors or in areas where HVAC systems cannot

be compromised. When welding or using internal combustion powered tools during the construction process, perform these activities in areas where dust and emissions can be captured and exhausted using temporary exhaust systems. When performing activities that generate VOCs, isolate these areas and exhaust the fumes, odors, and emissions using local or temporary exhaust systems.

- F. Smoking shall be prohibited in all areas inside the building.

3.3 PATHWAY INTERRUPTION

- A. During construction, isolate areas of work to prevent contamination of clean or occupied spaces. When possible use 100% outside air ventilation (depending on climate) with air exhausted directly to the outside during installation of finishes and other Volatile Organic Compounds emitting materials and performance of activities that generate dust or odor. Pressure differential can be used to prevent unwanted airflow from dirty to clean areas. This requires the erection of barriers between work areas or between the inside and outside of the building. Where possible, erect barriers such as dust curtains or plastic sheets between work areas to prevent unwanted air flow from dirty to clean areas.

3.4 HOUSEKEEPING

- A. Reduce construction contaminants in the building prior to occupancy through regular space cleaning activities. Construction areas should be cleaned at regular intervals to suppress and control the distribution of contaminants generated during the construction process. Remove spills of construction materials and/or accumulated water as soon as possible.
- B. All absorptive building materials and equipment to be installed, to include but not limited to drywall, carpet, ceiling tiles, insulation, shall be stored in weather tight, dry conditions, and up off floors, prior to installation.
- C. Check for possible damage to the system from high humidity. All coils, air filters, and fans shall be cleaned before testing and balancing procedures are performed and especially before baseline air quality tests are conducted (if applicable).

3.5 SCHEDULING

- A. Specify construction sequencing to reduce absorption of Volatile Organic Compounds or contamination by construction dust or emissions by materials that act as sinks or contaminant sources. Complete application of wet and odor-emitting materials such as paints, sealants, and coatings before "sink" materials such as ceiling tiles, carpets, insulation, gypsum products, and fabric-covered furnishings are installed. Materials that are susceptible to microbial growth shall be protected from exposed to moisture through precipitation, plumbing leaks, or condensation from the HVAC system contamination.

3.6 AIR QUALITY TESTING

- A. Conduct baseline indoor-air-quality testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air," and as additionally detailed in the USGBC's "LEED-CI: Reference Guide."

1. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:
 - a. Formaldehyde: 50 ppb.
 - b. Particulates (PM10): 50 micrograms/cu. m.
 - c. Total Volatile Organic Compounds (TVOC): 500 micrograms/cu. m.
 - d. 4-Phenylcyclohexene (4-PH): 6.5 micrograms/cu. m.
 - e. Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.
2. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting non-complying building areas, take samples from same locations as in the first test.
3. Air-sample testing shall be conducted as follows:
 - a. All measurements shall be conducted prior to occupancy but during normal occupied hours and with building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.
 - b. Building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Non-fixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.
 - c. Number of sampling locations will vary depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq. ft. or for each contiguous floor area, whichever is larger, and shall include areas with the least ventilation and greatest presumed source strength.
 - d. Air samples shall be collected between 3 and 6 feet from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.

END OF SECTION 018119

**SECTION 01 9113
GENERAL COMMISSIONING REQUIREMENTS**

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 and other applicable Sections, apply to Work of this Section. Failure to meet Cx requirements and failure to correct noncompliance and/or deficiencies subjects the Contractor to withholding of payments and completion. See General Conditions.
- B. Section 01 91 15 Commissioning Plan (Cx Plan) – Stipulates the relationships between the parties involved with the Cx process. Defines the milestones in completion incorporating the Cx process.
- C. Section 01 77 00 Closeout Procedures: Provides general requirements and specifications for O&M Documentation for Work across all Divisions.

1.2 REFERENCE STANDARDS

- A. ASHRAE Guideline 0-2013, *The Commissioning Process*, American Society of Heating, Refrigeration, and Air Conditioning Engineers, Atlanta, GA. www.ashrae.org
- B. ASHRAE Guideline 1.1-2007, *The HVAC Commissioning Process*, American Society of Heating Refrigeration, and Air Conditioning Engineers, Atlanta, GA. www.ashrae.org
- C. ASHRAE Guideline 4-2008, *Preparation of Operating and Maintenance Documentation for Building Systems*, American Society of Heating Refrigeration, and Air Conditioning Engineers, Atlanta, GA. www.ashrae.org
- D. National Environmental Balancing Bureau, 'Procedural Standards for Building Systems Commissioning'.

1.3 SUMMARY

- A. Commissioning (Cx) is a systematic process of ensuring that building systems perform interactively according to the design intent and the owner's operational needs. For purposes of this project, the Cx process occurs during the design, construction, acceptance, and occupancy phases. The objectives of this Cx process are as follows:
 - 1. Ensure that installed systems are operable and maintainable.
 - 2. Maintain a high level of quality assurance.
 - 3. Test and verify the applicable heating, ventilating, and air conditioning (HVAC), domestic water, and electrical systems to ensure they are interacting and performing optimally.
 - 4. Ensure proper documentation of the Cx process including meeting minutes, equipment start-ups, pre-functional checklists (PFC), and functional performance tests (FPTs). (Responsible party for completing specific documentation is outlined in Cx responsibilities section.)
 - 5. Identify, track, record, and report all system and equipment deficiencies in the Cx Issues Log.

6. Provide technical expertise for the correction of deficiencies.
7. Ensure O&M documentation delivered to Owner is complete.
8. Verify Training on all Commissioned Systems is carried out and properly documented.
9. Document warranty start and end dates.
10. Conduct ten month review of Commissioned Systems in accordance with LEED.

1.4 DEFINITIONS AND ABBREVIATIONS

- A. Refer to the Cx Plan for additional definitions and abbreviations related to the Cx process.
- B. Commissioning Agent (CxA): Independent firm retained by the Owner to conduct the Cx Program. The CxA shall work with the various subcontractors, the Architect, and the Engineer-of-Record (EOR) to direct and oversee the Cx process and perform Functional Performance Testing (FPT).
- C. Commissioning Milestones: Cx Milestones are scheduled events that mark defining progress completion points in the execution of the Cx process. Cx Milestones include specific Meetings and Training Events as defined in the Cx Plan. Regularly scheduled construction progress or working meetings are not considered Cx Milestones.
- D. Commissioning Plan (Cx Plan): The Cx Plan outlines the entire Cx process in detail. The Cx Plan is part of the Contract Documents and outlines many of responsibilities, procedures and tasks throughout the Cx process from Design through Occupancy. It also indicates the details of the FPT that the Construction Manager (CM) and associated Contractors must participate in. The Cx Plan provides a detailed description of the work required by the CxA. Further, it is imperative that the CM and all associated Contractors read and understand the implications and procedures outlined in the Cx Plan prior to submitting their bid for the Work.
- E. Commissioning Program: This is a general reference to the entire Cx process and associated documents. The Cx process refers to all work described in the Cx Plan and all other specification sections relating to Cx.
- F. Commissioning Team: The group of individuals who will collaborate to ensure the facility is fully and completely commissioned. The Cx Team will generally include a core group of individuals involved with all systems. This core group shall include the CxA, the GC, the Owner, and Owner's Construction Manager (if applicable). On any given system, the team will also include the member of the contractor(s) responsible for the systems or equipment.
- G. Functional Performance Test(ing) (FPT): The detailed and thorough testing of the building systems and their interactions with the building components and other building systems to ensure they are operating in accordance with the final design intent. Testing is performed in various modes of operation and conditions. Both component performance and environmental design objectives will be monitored during this testing. Functional Performance Tests (FPTs) are tests developed by the CxA with input from appropriate Cx Team members that, when passed, indicate Functional Completion of the system or equipment.

1.5 COMMISSIONING TEAM

- A. The CxA shall designate a Commissioning Team (Cx Team) consisting of all members needed to execute the approved Cx Program. Definitions of these Parties are provided in

the Cx Plan. Minimum Cx Team participation shall include:

1. CxA
2. Owner's Representatives (Owner)
3. Controls Contractor (CC)
4. Mechanical Contractor (MC)
5. Plumbing Contractor (MC)
6. Testing, Adjusting, and Balancing (TAB) Contractor
7. Electrical Contractor (EC)
8. Architect

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 COMMISSIONED SYSTEMS

- A. The following mechanical and electrical systems, equipment and components will be commissioned by Kibart, Inc., the CxA under this project. Where applicable, sampling may be used to test the equipment listed below. Refer to the Cx Plan for sampling rates. This would allow for a representative portion of the equipment to be tested and not every unit. All general references to the equipment in this document refer only to equipment that shall be commissioned.

1. 100% of central heating and cooling plants, including pumps, cooling towers, combustion air systems, etc.
2. 25% with sampling interior lighting and associated control system.
3. 5% of test and balance verification.
4. Building Automation System in proportion to commissioned systems.

3.2 COMMISSIONING MILESTONES AND PARTICIPANTS

- A. The following are the Cx Milestones (Cx-specific meetings and training events) required under this Contract. Complete descriptions, including Schedule and Attendees, are provided in the Cx Plan. They are provided here as a summary for the Contractor and associated Contractors. These Milestones are in addition to regular construction progress meetings and FPTs that are scheduled as systems and equipment are ready for testing.

1. *Construction Phase Commissioning Scoping Meeting.* Required Attendees include the CxA (lead), Construction Manager (CM), and Mechanical, Electrical, and Controls Contractors. Other required attendees include Owner Representatives, EOR, and Architect.
2. *Commissioning Progress Meetings.* Required Attendees include the CxA (lead), CM, and Mechanical, Electrical, and Controls Contractors. Other required attendees include Owner Representative, and Tab Contractor.
3. *Owners Training of Cx Systems.* Required Attendees include the CxA (lead), Construction Manager (CM), Owner Representatives and Operators. Applicable contractors and EOR may also be required.
4. *Final Cx Meeting.* Required Attendees include the CxA (lead), CM, and all Contractors involved in the Cx Team. Other required attendees include Owner Representatives, EOR, and Architect.

3.3 COMMISSIONING DOCUMENTATION

- A. The Design Phase Cx Plan is written by the CxA and included in the Contract Documents. The Plan shall be updated regularly to reflect the most up-to-date status of commissioning throughout the project's lifecycle.
- B. The Cx Issues Log shall be maintained by the CxA. It is used to track Cx-related issues or deficiencies found throughout the project. Refer to the Cx Documentation section in the Cx Plan for more information.
- C. CxA shall require Submittals relating to key systems or equipment from the Contractor as specified in the Cx Plan to ensure Owner's Requirements are met and facilitate the preparation of FPTs. Review is for Cx facilitation only and does not replace the Submittal Review of the Architect or EOR.
- D. The TAB Contractor is responsible for submitting a TAB Plan, in accordance with the Cx Plan, prior to beginning TAB of the building.
- E. The Controls Contractor (CC) is responsible for submitting a Controls Checkout Plan, in accordance with the Cx Plan, prior to beginning TAB of the building.
- F. The Contractor will provide the CxA with initial "generic" Pre-Functional Checklists for all equipment being commissioned for review. The Contractor is responsible for completing the Pre-Functional Checklists and Start-up Reports in accordance with the Cx Plan and other Contract Documents. The Contractor shall deliver completed Start-up Reports and Pre-Functional Checklists to the CxA for review prior to scheduling FPTs.
- G. The FPT procedures shall be developed by the CxA and provided to the Contractor for review prior to the start of the FPTs. Refer to the Cx Plan for additional information.
- H. The Contractor shall develop a Training Plan in accordance with the Cx Plan and other Contract Documents.
- I. The Contractor shall develop the Operation and Maintenance Manuals in accordance with the Cx Plan and other Contract Documents.

3.4 SEQUENCING AND SCHEDULING COMMISSIONING TASKS

- A. Contractor shall incorporate the Cx Program into the project schedule and timelines.
- B. Cx tasks to be separately indicated in the project schedule include but are not limited to:
 - 1. Start-Up: Indicate time required to properly perform Start-Up of each system and complete Start-Up Documentation.
 - 2. TAB: Include sufficient time for TAB work to be completed and checked.
 - 3. FPT: Indicate time required for FPTs, itemized as applicable for each system/area. Coordinate duration for the tasks with the CxA.

3.5 COMMISSIONING PROTOCOLS

- A. Coordination responsibilities and management protocols relative to Cx are initially defined in the Cx Plan and will be refined and documented at the *Construction Phase Cx Scoping Coordination Meeting* and also by scheduled updates to the Cx Plan. Contractor shall have input in the protocols and all Parties will commit to scheduling obligations. The CxA will record and distribute.

3.6 COMMISSIONING RESPONSIBILITIES

A. General

1. All parties involved in the design and construction of the facility bear responsibility in the Cx Program. The Cx Program does not fundamentally change the responsibilities of the team members from conventional projects carried out without a formal Cx Program. The Cx Program supplements and formalizes the responsibilities of all parties.
2. The role of the CxA is to oversee the Cx Program and to assist all other parties in achieving the goals of the project. Refer to the Cx Plan for further detail.
3. The Contractor (and associated Sub-Contractors) retains all responsibility for the installations. CxA inspections and tests will determine the adequacy and completeness of the installations to assist the Contractor in providing a sound installation. CxA testing does not alleviate the Contractor's responsibility for ensuring the systems are complete and functional throughout the Warranty Period.
4. Detailed responsibilities for the Mechanical Contractor and associated Sub-Contractors are indicated below. Refer to the Cx Plan for detailed responsibilities for other Contractors and Cx Team members. These responsibilities relate solely to the Cx Program and do not encompass all aspects of the project.
5. Some scopes or tasks indicated in the following list of responsibilities are further detailed in other subsections of the Cx Plan, including descriptions of meetings, training events, and required reports.

B. Mechanical Contractor's (MC) Responsibilities

1. Attend Cx meetings, FPTs, and Training as outlined in the specifications, the Cx Plan, and as summarized in this subsection.
2. Include requirements for submittal data, including O&M data and training materials in each purchase order or sub-contract written. Provide submittals in electronic format originating from the manufacturer to ensure the highest resolution/quality.
3. Ensure cooperation of other Sub-Contractors as necessary.
4. Ensure cooperation and participation of specialty Sub-Contractors as necessary.
5. Ensure participation of major equipment manufacturers and their representatives as needed. Note all commissioned equipment that is standalone or provided with factory mounted controls will require the support of the start-up technicians during Cx FPTs.
6. Gather O&M data on all equipment and assemble electronically. Provide electronic manuals in accordance to Sections 01770 Closeout Procedures and other related Sections. Submit to CM/GC after the equipment has been placed. O&M data shall be forwarded to CxA for use in preparing FPTs.
7. Attend Cx meetings and training events as outlined in the Cx Plan and other Contract documents.
8. Participate in and schedule vendors and Sub-Contractors to participate in the training sessions outlined in this plan and Contract Documents.
9. Conduct Maintenance Orientation and Inspection Meetings at the Equipment Placement and Distribution Completion stages. Update drawings electronically to the record condition to date, and review with the CxA prior to each Meeting.
10. Prepare necessary preliminary schedule for maintenance orientation and inspection meetings, O&M manual submission, training sessions, and equipment start-ups, TAB start and job completion for use by the CxA. Update schedule as appropriate throughout the construction period.
11. Notify the CxA of the time for start of the TAB work. Attend the TAB

12. Concurrence Meeting for review and acceptance of proposed TAB procedures.
13. Attend and participate in all Cx FPT's per the Cx Plan.
14. Provide all training in accordance with Contract Documents. Video tape training if required in the project specifications.
15. The appropriate Contractor Representative or Manufacturer's Representative (in the case of factory testing and startup) shall provide written certification that the following work has been completed in accordance with the plans and specifications and that they are functioning as designed. Where the Work has been subcontracted, the Sub-Contractor shall be responsible for the initial certification with the primary Contractor Representative re-certifying that he has inspected the Work and that it has been completed and functioning as designed. This certification must be submitted to the CxA prior to the final verification. Certifications are required for the following systems:
 - a. HVAC equipment including all Boilers and associated Heat Pumps
16. Assist the CxA in documentation and verification of equipment and system performance, including but not limited to FPTs. Schedule the Sub-Contractors (including but not limited to TAB, CC) to assist during FPTs as required.
17. Provide all tools and equipment necessary to perform FPTs, including those necessary for simulation of false loading as required by the CxA.
18. Turn over set of record mark-ups to the Mechanical and Plumbing EORs for final incorporation into Record Documents.
19. Refer to Division 23 and other applicable specification sections for specific start-up procedures for HVAC equipment. Unless otherwise noted, these procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct. The manufacturer start-up forms shall be completed and submitted to the CM/GC and CxA for review in accordance with the Cx Plan.

C. Electrical Contractor's (MC) Responsibilities

1. Attend Cx meetings, FPTs, and Training as outlined in the specifications, the Cx Plan, and as summarized in this subsection.
2. Include requirements for submittal data, including O&M data and training materials in each purchase order or sub-contract written. Provide submittals in electronic format originating from the manufacturer to ensure the highest resolution/quality.
3. Ensure cooperation of other Sub-Contractors as necessary.
4. Ensure cooperation and participation of specialty Sub-Contractors as necessary.
5. Ensure participation of major equipment manufacturers and their representatives as needed.
6. Gather O&M data on all equipment and assemble electronically. Provide electronic manuals in accordance to Sections 01770 Contract Closeout Procedures and other related Sections. Submit to CM/GC after equipment has been placed. O&M data shall be forwarded to CxA for use in preparing FPTs.
7. Attend Cx Milestone meetings and training events as outlined in the Cx Plan.
8. Attend and participate in all CxA FPT's per the Cx Plan.
9. Provide all training in accordance with Contract Documents. Video tape training if required in the project specifications.
10. Assist the CxA in documentation and verification of equipment and system performance, including but not limited to FPTs.
11. Provide all tools and equipment necessary to perform FPTs, including those necessary for testing and operation of all Commissioned systems, as required by the CxA.
12. Turn over set of record mark-ups to the Electrical EOR for final incorporation into Record Documents.

13. The Electrical Contractor (EC) may be required for participation in start-ups of mechanical equipment, operation of electrical starters, breakers, etc., pre-functional checklists, and some aspects of the mechanical systems FPTs.
14. The appropriate Contractor or Manufacturer's Representative (in the case of factory testing and startup) shall provide written certification that the following work has been completed in accordance with the plans and specifications and that they are functioning as designed. Where the Work has been subcontracted, the Sub-Contractor shall be responsible for the initial certification with the primary Contractor re-certifying that he has inspected the Work and that it has been completed and functioning as designed. This certification must be submitted to the CxA prior to the final verification. Certifications are required for the following systems:
 - a. Interior lighting and associated controls
15. Refer to Division 26 and other applicable specification sections for specific start-up procedures for electrical equipment. Unless otherwise noted, these procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct. The manufacturer start-up forms shall be completed and submitted to the CM/GC and the CxA for review in accordance with the Cx Plan.

D. Controls Contractor's (CC) Responsibilities

1. All requirements of MC and EC shall apply as applicable to the CC, including requirements for Submittals, O&M manuals and data, and training data and materials.
2. The CC is a crucial member of the Cx Team and will be required to be available for most FPTs, as well as verify, demonstrate and train the Operators on the overall system operation and sequence of operation. The CM shall ensure that the CC is made fully aware of his/her role and importance to a successful Cx effort.
3. Attend Cx Milestone meetings and training events as outlined in the Cx Plan and also as specified in appropriate control systems specification Section.
4. Attend and participate in all Cx FPT's per the Plan and spec. sections. The CC shall be required to demonstrate all control and system sequences of operation to the CxA and other members of the Cx Team.
5. Provide and participate all training in accordance with Contract Documents.

E. Testing, Adjusting, and Balancing Contractor's (TAB) Responsibilities

1. Perform all Work as specified in construction specifications.
2. Submit a TAB work plan as a formal Cx submittal for Cx review and approval. If this is already being submitted to the EOR then a separate Cx submittal is not required.
3. Attend initial Cx Scoping Meeting scheduled by the CxA.
4. At the completion of the TAB work, notify the MC, and demonstrate to the CxA the performance of the equipment covered by the TAB sub-contract.
5. Repeat any measurement contained in the TAB report where required by the CxA for verification or diagnostic purposes.
6. Provide and participate in all training in accordance with Contract Documents.

F. Equipment Suppliers and Miscellaneous Specialty Contractors

1. Attend Meetings as outlined in the Cx Plan.
2. Participate in training sessions as outlined in the Cx Plan and other Contract documents.

3. Demonstrate performance of equipment as applicable.

3.7 CONTRACTOR NOTIFICATIONS

- A. Contractors shall completely install, thoroughly inspect, start-up, test, adjust, and balance systems and equipment. All activities shall be documented on Start-Up Documentation forms developed by the Contractor and reviewed by the CxA. The Contractor shall notify Owner and CxA in writing that systems are complete and ready for verification and FPT. CxA shall then coordinate and schedule the FPT and notify all Cx Team members.
- B. Contractor shall notify CxA at least 14 days in advance of any tests, startups, or training. CxA shall witness selected tests and startups.

3.8 START-UP AND PRE-FUNCTIONAL TESTING PROCEDURES

- A. The Contractor shall provide pre-functional checklists and start-up reports to the CxA electronically. The Contractor is responsible for completing these forms and submitting the completed forms to the CM and CxA for review in accordance with the Cx Plan.
- B. Functional Performance Tests provide the final metric for CxA approval and are provided by the CxA in the Cx Plan. Contractor shall consult the most current version of the Cx Plan to determine applicable FPTs that will be used for system acceptance.

3.9 GENERIC FUNCTIONAL PERFORMANCE TESTS (FPT)

- A. General
 1. Contractor shall refer to the Cx Plan for detailed information concerning the scheduling, prerequisites, and generic system/equipment testing requirements for the functional performance tests.

END OF SECTION



COMMISSIONING PLAN

FOR

Goucher College – Interfaith Chapel

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January 5, 2017

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I. INTRODUCTION

A. Commissioning Plan (Cx Plan)

1. This Cx Plan outlines the procedures, requirements, and responsibilities of all Cx Team members for the Goucher College Interfaith Chapel throughout design, construction, and acceptance phases. The Commissioning Agent (CxA) will use the Cx Plan to ensure that the Interfaith Chapel is designed, installed, started, tested, and documented to meet the needs of the Goucher College (Owner).

II. PROJECT DESCRIPTION

A. Facility Description

1. Goucher College is renovating the 2-story Haebler Memorial Chapel to be more of an inclusive multi-faith space. The project is to include the establishment of several unique program spaces: a shared space, multi-faith center program, and space for the Hillel Center program. Renovation of the Chapel will include removal of the pews, addition of an ablution station(s), potential accessible toilet room, additional lighting, selection of new furniture, new storage, modification to the exterior wall at the connection to the addition, potential reworking of the undercroft plan layout, modifications to the altar, and the removal of existing iconography.

B. LEED Goal

1. Goucher College is pursuing LEED New Construction under LEED BD&C v3.0 for the Interfaith Chapel project.
2. The following Commissioning Credits are anticipated:
 1. EAp1 – Fundamental Commissioning
 2. EAc3 – Enhanced Commissioning

III. COMMISSIONED SYSTEMS (TABLE 3.1)

<i>Equipment</i>	<i>Description</i>	<i>% Tested¹</i>	<i>Submittal Required</i>
Building Automation System			
BAS		Note 2	Yes
TAB Verification	Random Sampling	5%	Yes
HVAC SYSTEMS			
HWCW Equipment	All associated equipment in new mechanical room.	100%	Yes
ELECTRICAL SYSTEMS			
Interior Lighting	Including Associated Controls	25%	Yes

Equipment	Description	% Tested¹	Submittal Required
<i>Notes:</i>			
	1. Maximum failure rate for sampling 10%		
	2. The BAS will be tested for all of the applicable equipment being tested during the equipment FPTs.		

IV. COMMISSIONING OVERVIEW

A. Definitions

1. Cx is a systematic process of ensuring that building systems perform interactively according to the design intent and the owner's operational needs. For purposes of this project, the Cx process occurs during the design, construction, acceptance, and post-occupancy phases.
2. Design Phase - During this phase the Cx Agent (CxA) reviews the drawings and specifications for accuracy and completeness. The CxA shall also review the Owner's Project Requirements (OPR) and ensure that the Basis of Design (BOD) meets the intent of the OPR. During this phase the Cx Plan and Cx Specifications are developed and submitted as part of the Contract Documents for the project. A technical peer review of the A/E Design for the systems being commissioned is also conducted prior to the mid-point of construction documents with a back-check of the final bid to ensure design review comments were appropriately addressed.
3. Construction Phase - Engineer-of-Record (EOR) and CxA shall concurrently review the Shop Drawings for all the Commissioned Systems in accordance with this Cx Plan and other Contract Documents. CxA also reviews Cx specific submittals. Equipment is installed and equipment start-ups and pre-Functional testing is performed by the Contractors. Pre-functional checklists are to be developed by the Contractor and reviewed prior to their completion by the CxA. Start-up Documentation is submitted to and reviewed by the CxA. The CxA shall write the Functional Performance Testing (FPT) procedures during this phase.
4. Acceptance Phase - FPTs are performed by the Cx Team with key roles being played by the CxA and Controls Contractor. The Contractor is responsible for demonstrating commissioned systems as directed by the CxA. The CxA shall maintain the Cx Issues Log. The Contractors shall conduct Owner Systems Training, and the CxA shall assist in development of the training and verification of its performance. At the end of this phase the CxA shall issue the Cx Systems Manual including the Cx Plan, meeting minutes, issues log, test reports, start-up reports, pre-functional performance tests, FPT Reports, and training documents. The CxA shall also execute LEED related Cx documentation.
5. Occupancy Phase – The Owner operates and maintains the facility per the design intent and informs the design and construction teams of any problem.

Architect and EOR shall respond to design related deficiencies discovered during the warranty period. Contractors shall provide warranty service as specified in the Contract Documents. The primary role of the CxA during this phase is to conduct the 10 month post-occupancy review in accordance with LEED requirements.

B. Objectives

1. Ensure that installed systems are operable and maintainable
2. Test controls sequences to ensure that all building systems are interacting correctly with control systems.
3. Document Cx Process
 1. Meeting Minutes
 2. Equipment Start-ups / Pre-functional Checklists
 3. Functional Performance Tests
4. Identify, track, record, and verify resolution of all system and equipment deficiencies in the Cx Issues Log.
5. Meet all Cx requirements for LEED BD&C v3.0 credits:
 1. EAp1 – Fundamental Commissioning
 2. EAc3 – Enhanced Commissioning

V. COMMISSIONING RESPONSIBLE PARTIES (TABLE 5.1)

Title and Company	Contact Information (name, e-mail, phone, fax, address)
Commissioning Agent (CxA) - Kibart, Inc.	Michael Myer msm@kibart.com Bruce Sewell bws@kibart.com Ph: 410-494-1111 901 Dulaney Valley Rd, Ste 301 Towson, MD 21204
Owner – Goucher College	
Design Team	
Architect (Design) – Ayers Saint Gross	
MEP Design-	
Construction Team	
General Contractor (GC) – Whiting Turner	
Mechanical Contractor (MC) -	
Electrical Contractor (EC)-	
Testing, Adjusting, and Balancing Contractor (TAB)-	

Title and Company	Contact Information (name, e-mail, phone, fax, address)
Controls Contractor (CC) -	

VI. ROLES AND RESPONSIBILITIES

A. General

1. All parties involved in the design and construction of the facility bear responsibility in the Cx Program. The Cx Program does not fundamentally change the responsibilities of the team members from conventional projects carried out without a formal Cx Program. The Cx Program supplements and formalizes the responsibilities of all parties.
2. The role of the CxA is to oversee the Cx Program and to assist all other parties in achieving the goals of the project.
3. The Contractor (and associated Sub-Contractors) retains all responsibility for the installations. CxA inspections and tests will determine the adequacy and completeness of the installations to assist the Contractor in providing a sound installation. CxA testing does not alleviate the Contractor's responsibility for ensuring the systems are complete and functional throughout the Warranty Period.
4. Detailed responsibilities are indicated below. These responsibilities relate solely to the Cx Program and do not encompass all aspects of the project.
5. Some scopes or tasks indicated in the following list of responsibilities are further detailed in other subsections of the Cx Plan, including descriptions of meetings, training events, and required reports.
6. Only the responsibilities related specifically to the Cx scope are listed herein. All team members have additional responsibilities, as part of their overall contract scope, which are not included here.

B. CxA

1. Design
 1. Write Cx Plan and Specifications
 2. Review Design of SDs, DDs, 50% CDs, and 100% CDs (Cx Coordination).
 3. Review OPR and BOD
 4. Technical Peer Review of the Construction Documents prior to 50% CDs.
 5. Back-check of Construction Documents prior to bid.
 6. Attend other Cx Related Meetings as needed
2. Construction
 1. Coordinate and Execute Cx Program
 2. Update Cx Plan

3. Conduct Construction Phase Commissioning Scoping Meeting
 4. Review Shop Drawings for Commissioned Systems
 5. Conduct the Controls Coordination Meeting. Meeting will be scheduled after the BAS Shop Drawing has been submitted and reviewed by the CxA and EOR.
 6. Review Start-up and review Pre-Functional Checklist forms submitted prior to the start of Pre-Functional Tests and Start-up.
 7. Schedule and Run Cx meetings
 8. Develop FPTs including detailed system and equipment specific test procedures and documentation.
 9. Create and Maintain Issues Log
 10. Inspect installations
 11. Attend Progress Meetings as needed.
 12. Review O&M Documentation
3. Acceptance
 1. Direct and Perform FPTs
 2. Maintain FPT Documentation
 3. Maintain Issues Log
 4. Issue Final Cx Report
 4. Occupancy
 1. Conduct ten month review of commissioned building systems.

C. Owner

1. Design
 1. Select a CxA
 2. Respond to Owner-specific Design Review comments.
 3. Provide Owner's Project Requirements documentation.
2. Construction
 1. Owner or Owner Representative shall attend Cx Meetings and Inspections at Owner's discretion.

3. Acceptance
 1. Owner or an Owner's Representative shall Witness FPTs at Owner's discretion.
 2. Attend and record contractor provided systems training.
4. Occupancy
 1. Operate and maintain the facility per the design intent.
 2. Inform the design and construction teams of any problems operating the building systems.
 3. As part of the maintenance program, trend or log system parameters and document any deficiencies.
 4. Inform the Design Team and/or Contractor of any changes to the systems and the reason for the change.

D. Architect

1. Design Phase
 1. Incorporate Cx specification sections into the Construction Specifications.
 2. Respond to Cx Design Review Comments. Incorporate necessary revisions into the Contract Documents.
2. Construction Phase
 1. Include status of the Cx Program as a discussion item in all Construction Progress Meetings.
 2. Attend Cx Meetings as outlined in the Cx Plan.
 3. Include CxA in the Progress Meeting Minute distribution list.
 4. Inform CxA of design changes during construction.
 5. Include CxA in distribution of applicable equipment submittals for concurrent EOR and Cx review. CxA will coordinate with Cx Team to identify specific submittals required for CxA review. Shop Drawings for all Commissioned Systems including the BAS must be submitted to the CxA for review.
3. Acceptance Phase
 1. Witness FPTs as required by Contract
 2. Resolve any architectural Issues identified by the CxA
 3. Attend Cx Meetings as outlined in the Cx Plan

4. Occupancy Phase
 1. Respond to Design related deficiencies discovered during the warranty period.

E. Engineer of Record (EOR) – Mechanical, Electrical, Plumbing

1. Design
 1. Coordinate with CxA to include specific Cx language in specification sections of system drawings.
 2. Respond to Cx Design Review Comments. Incorporate necessary revisions into the Contract Documents.
 3. Provide Basis of Design that meets the OPR.
2. Construction Phase
 1. Review CxA comments of Shop Drawings designated for concurrent EOR and CxA review. Cx comments must be incorporated into EOR comments to make them legally binding. EOR shall coordinate with the CxA concerning any comments not incorporated.
 2. Attend Cx Meetings as outlined in the Cx Plan.
3. Acceptance Phase
 1. Resolve any Engineering Issues identified by the CxA.
4. Occupancy Phase
 1. Respond to Design related deficiencies discovered during the warranty period.

F. General Contractor

1. Construction Phase
 1. Include Cx requirements in price and plan for Work.
 2. Itemize Cx related tasks and milestones in the project schedule.
 3. Provide copies of all Construction Progress Meeting minutes to the CxA.
 4. Attend Cx Meetings as outlined in the Cx Plan
 5. Include CxA in distribution of applicable equipment submittals for concurrent EOR and Cx review. CxA will coordinate with Cx Team to identify specific submittals required for CxA review. Shop Drawings for all Commissioned Systems including the BAS must be submitted to the CxA for review.

6. Schedule all Sub-Contractors and vendors for Cx-related events. Ensure that the Controls Contractor is made fully aware of the role and importance of a complete and functional controls system to a successful Cx effort.
 7. Certify that systems have been installed and are operating per Contract Documents and have met all Cx Prerequisites prior to Acceptance Phase.
 8. Develop and complete pre-functional checklists for all commissioned equipment. Pre-functional checklists shall be delivered to the CxA for review before and after their completion.
 9. Maintain a binder of all start-up forms, pre-functional checklists, and test reports Work with Sub-contractors to complete all Start-Up Documentation and testing. Once completed, submit binder to the Owner and CxA for review. Depending on schedule of testing and start-ups multiple submissions may be required.
 10. Demonstrate systems as specified.
2. Acceptance Phase
1. Assist CxA with system verification and FPTs by testing and demonstrating systems as directed.
 2. Schedule all Sub-Contractors and vendors to assist with the execution of the FPTs and attend other Cx-related events. Provide all tools and equipment necessary to perform FPTs, including those necessary for testing and operation of all Commissioned systems, as required by the CxA.
 3. Provide Owner Systems Training in accordance with Contract Documents.
 4. Resolve any Construction Issues identified by the CxA.

G. Sub-Contractors

1. All Sub-Contractors
 1. Attend Construction Phase Cx Scoping Meeting.
 2. Attend Cx meetings, FPTs, and training events as outlined in the Cx Plan and specifications, unless told otherwise by the CxA or Owner.
 3. Assist the CxA in documentation and verification of equipment and system performance, including but not limited to FPTs.
 4. Provide written certification that the work is complete and operates in accordance with the contract documents.
 - a. In the case of factory testing and startup, the manufacturer shall provide written certification that the Work is complete and operates as designed in accordance with the contract documents.

- b. Where the Work has been subcontracted, the Subcontractor shall be responsible for the initial certification. The primary Contractor will inspect the Work and re-certify that it is complete and functions as designed. The written certification must be submitted to the CxA prior to the start of FPTs.
2. Mechanical
 1. Refer to “All Sub-Contractors” section for additional requirements.
 2. Sub-Contractors shall submit Start-up Documentation for review and approval. Start-up documentation and Pre-functional Checklists shall be provided to the CxA for all commissioned equipment. Pre-functional Checklists shall be utilized and populated by the Sub-Contractors during Start-up and submitted for record with the start-up documentation.
 3. Submit Installation Certification Information such as Balancing Reports, Warrantees, and Duct and Pipe Test Results for CxA review.
 4. Schedule Sub-Contractors including the Controls and TAB Contractors to assist during FPTs, as required. The Controls Contractors will typically be required during all Mechanical FPTs.
 5. Coordinate with the major equipment manufacturers to provide representation during FPTs. All major commissioned equipment that is standalone or provided with factory mounted controls will require the support of the start-up technicians during Cx FPTs. The start-up technicians must be knowledgeable in the demonstration, testing, and troubleshooting of the commissioned equipment.
 3. Electrical
 1. Refer to “All Sub-Contractors” section for additional requirements.
 2. Attend and participate in all Cx FPT’s per the Cx Plan, unless told otherwise by the CxA. Schedule Sub-Contractors (lighting control system representative) to assist during FPTs, as required.
 3. Sub-Contractors shall submit Start-up Documentation for review and approval. Start-up documentation and Pre-functional Checklists shall be provided to the CxA for all commissioned equipment. Pre-functional Checklists shall be utilized and populated by the Sub-Contractors during Start-up and submitted for record with the start-up documentation.
 4. Submit completed start-up forms and pre-functional checklists to the CxA for review.
 5. Submit Installation Certification Information such as Warrantees, and Test Results for CxA review.
 6. Coordinate with the major equipment manufacturers to provide representation during FPTs. All commissioned systems that are standalone or provided with factory mounted controls will require the

support of the start-up technicians during Cx FPTs. These systems may include lighting control or the generator. The start-up technicians must be knowledgeable in the demonstration, testing, and troubleshooting of the commissioned equipment.

7. Participate in portions of start-ups of mechanical equipment; operate electrical starters, breakers, and other electrical equipment; complete pre-functional checklists; and provide assistance in some aspects of the mechanical systems FPTs, as required.
4. Controls
 1. Refer to "All Sub-Contractors" section for additional requirements.
 2. Attend the Controls Coordination Meeting. Meeting will be scheduled after the BAS Shop Drawing has been submitted and reviewed by the CxA and EOR.
 3. Attend and participate in all Cx FPT's per the Cx Plan. Demonstrate all control and system sequences of operation to the CxA and other members of the Cx Team.
 4. Verify, demonstrate, and train the Owner on the overall system operation and sequence of operation.
5. TAB
 1. Refer to "All Sub-Contractors" section for additional requirements.
 2. Submit a TAB work plan for Cx review and approval.
 3. Submit completed TAB Report to the CxA and EOR prior to the start of the FPTs.
 4. Demonstrate the performance of the equipment and repeat measurements for Cx TAB Verification.
6. Manufacturer's Representatives.
 1. Refer to "All Sub-Contractors" section for additional requirements.
 2. Provide representation during FPTs. All commissioned equipment that is standalone or provided with factory mounted controls will require the support of the start-up technicians during Cx FPTs. The start-up technicians must be knowledgeable in the demonstration, testing, and troubleshooting of the commissioned equipment.

VII. COORDINATION AND COMMUNICATION

A. Cx Coordination

1. CxA will document requirements for the coordination of all Cx activities throughout the construction process. CxA shall communicate the requirements of Cx for the construction phase at the Cx Scoping Meeting in which the Construction Phase Cx Plan is presented and reviewed.
2. CxA shall solicit participation of the appropriate parties and document that the tasks are being executed and that responsibilities are being met.
3. CxA shall regularly report progress of Cx to Owner and Architect.

B. Communication Protocols Relating to Cx

1. Communication from the CxA shall not be interpreted as a work directive. The CxA is contracted directly by Goucher College and has no authority to direct work by any contractors or design professionals. All channels for directing work are dictated in the agreements between the applicable parties.
2. The Cx Team email distribution list will be determined during the Cx Scoping Meetings and will be listed in the meeting minutes. Correspondence shall generally be routed directly between corresponding companies with copies going to all parties of the Cx Team. The primary exception to this is when it relates to an issuance of a directive. All directives shall be provided by the Architect or GC.
3. The CxA will communicate directly with the Owner, Architect, Engineer, and GC by phone or email to determine project status and answer general procedural questions. In the event that an email or phone conversation affects the project, a summary email of the conversation, or the email(s) in question will be forwarded to the rest of the Cx Team email distribution list.
4. Deficiencies or recommendations for improvements found during testing shall be tracked in the Issues Log. The Issues Log will be provided to the Cx Team email distribution list each time it is updated
5. Specific communications are listed in Table 7.1. Note that these procedures are intended as an initial guide:

Table 7.1 Cx Communication Protocols

Issue	Protocol
Cx Requests for information (RFI) or formal documentation:	CxA shall submit requests to the Owner and Architect. When necessary, copies shall be submitted to the EOR and Contractors.
For minor information or clarification, written or verbal:	CxA shall go directly to the applicable party.

Issue	Protocol
Identifying deficiencies; Notifying contractors of deficiencies:	<ol style="list-style-type: none"> 1. CxA shall track all identified deficiencies in the Cx Issues Log. 2. The Cx Issues Log shall be updated and issued by the CxA. 3. The CxA may discuss deficiency issues with contractors prior to notifying Owner. Copies of the Issues Log will be distributed to Architect, Owner, and Cx Team members. 4. Goucher College will make the final determination of how deficiencies will be addressed. 5. Recommendations may be made by the CxA or contractors based on system testing and observation.
Making small changes in specified sequences of operations:	The CxA may suggest small sequences of operations changes to improve efficiency or control, but does not fundamentally change the sequence. The CxA shall document all changes of specified sequences and provide copies to the Owner, Architect, and applicable EOR.
Scheduling of all Cx related events:	CxA shall consult directly with the Owner, Architect, and the GC to incorporate the Cx tasks in the master project schedule.
Scheduling FPTs:	The CxA coordinates and schedules FPTs based on Owner and team input. Owner provides final schedule approval.
Scheduling Cx meetings:	The CxA coordinates and schedules Cx meetings at a time convenient for attendees. Typically at the end of each Cx meeting the next meeting is tentatively scheduled.
Scheduling training:	The CxA does not schedule or witness any training.
Making a request for significant changes:	The CxA has no authority to issue change orders.
Sub-Contractors disagreeing with requests or interpretations by the CxA shall:	Try and resolve with the CxA first. Then work through Architect or Owner who will work with CxA directly to resolve the situation.

VIII. COMMISSIONING MEETINGS

A. Overview

1. Meetings: This subsection is a descriptive list of specific Cx Meeting during the Cx process. Cx Meetings are scheduled at milestones in the project schedule. Each Cx Meeting has a specific agenda and is usually scheduled adjacent to regular design and construction progress meetings. The meetings will lead by the CxA.
2. Tasks such as witnessing pipe cleaning/flushing and system startups, conducting periodic Cx inspections, and performing FPTs are not covered in this Section of the Cx Plan.

B. Construction Phase Cx Scoping Meeting

1. Description: Introduction of the Cx Construction team. The CxA shall coordinate with the Cx team to review the complete Cx Process and to ensure the team members are familiar with their specific responsibilities during the Construction and Acceptance phases.
2. Agenda Items:
 1. Review Cx Plan
 - a. Address process questions
 - b. Determine lines of reporting and communications
 - c. Discuss Work Products
 2. Determine tentative schedule and trigger points for follow-up meetings, deliverables, and key events.
 3. Discuss distribution and review of shop drawings relating to systems to be commissioned.
 4. Decide which systems will require Start-up Documentation and Functional Performance Testing.
 5. Define Cx Team Roles and Responsibilities
 6. Finalize communication protocols and identify points of contact for the Cx Team Email Distribution List.
 7. CxA will distribute meeting minutes to all team members and attendees within seven (7) days following the meeting.
3. Cx Team Email Distribution List: Owner designated team members who are included in all major Cx communications, including site visit scheduling, Issues Logs, FPT distribution, and Cx announcements which affect the project.
4. Schedule: The Construction Phase Cx Scoping Meeting shall be scheduled by the CxA during the Construction Phase at the start of the construction phase, prior to the start of submittal review.
5. Attendees: Any Cx Team member is eligible to attend. Required attendees include:
 1. CxA (lead);
 2. Owner Representatives;
 3. GC;
 4. Architect;

5. Mechanical, Electrical, Controls Contractors, and TAB Representative

C. Submittal Coordination Meeting

1. Description: This meeting shall be held to discuss open submittal review comments if they have not been able to be resolved through normal submittal review procedures. This will not address the Controls Submittal since it will be covered during the Controls Coordination Meeting.
2. Agenda:
 1. Review Submittal Comments from EOR and CxA.
 2. Determine resolutions for all review comments. Final resolution must be agreed upon by the Owner.
 3. Applicable Contractor shall revise the submittal as required to reflect the agreed upon changes.
 4. EOR shall revise the design documents as required to reflect the agreed upon changes.
 5. Owner shall revise the OPR document as required to reflect the agreed upon changes.
3. Schedule:
 1. The Submittal Coordination Meeting shall be scheduled by the CxA between 5 and 15 days after the submission of all the major shop drawings if necessary.
 2. This shall be scheduled in conjunction with a normal Cx Progress Meeting and/or the Controls Coordination Meeting. This would be held following the Progress meeting but prior to the Controls Coordination Meeting.
4. Attendees: Any Cx Team member is eligible to attend. Required attendees include:
 1. CxA (lead);
 2. Owner Representative;
 3. EOR;
 4. Mechanical, Electrical, and Controls Contractor
 5. Manufacturer Reps for all equipment with unresolved comments and manufacturer provided controls.

D. Controls Coordination Meeting

1. Description: When the Controls Contractor has prepared the Controls shop drawing for review by the EOR and CxA, the Controls Coordination Meeting

will be scheduled. The EOR and CxA will have a minimum of 5 days to review the submittal prior to the meeting. During the Controls Coordination Meeting, all attendees shall review the submittal and information about associated equipment to resolve conflicts between systems and confirm design intent with the Owner.

2. Agenda:

1. Review Controls Submittal Comments from EOR and CxA.
2. Discuss the following options to produce a complete and functional system:
 - a. Changes to the controls system
 - b. Changes to the controls design or sequences
 - c. Changes to the equipment or system design
 - d. Changes to the Owner's Project Requirements
3. Determine resolutions for all review comments. Final resolution must be agreed upon by the Owner.
4. Controls Contractor shall revise the submittal as required to reflect the agreed upon changes.
5. EOR shall revise the design documents as required to reflect the agreed upon changes.
6. Owner shall revise the OPR document as required to reflect the agreed upon changes.

3. Schedule:

1. The Controls Coordination Meeting shall be scheduled by the CxA between 5 and 15 days after the submission of the Controls shop drawings.
2. This meeting shall be held following a regular Cx progress meeting and Submittal Coordination Meeting.

4. Attendees: Any Cx Team member is eligible to attend. Required attendees include:

1. CxA (lead);
2. Owner Representative;
3. EOR;
4. Controls Contractor

5. Mechanical Contractor
6. Manufacturer Rep for packaged equipment that requires communications interface between the BAS and Equipment controllers.

E. Commissioning Progress Meetings

1. Description: Periodic meetings held throughout the Construction and Acceptance Phases to coordinate and facilitate the Cx process. Meetings will be used to address Issues, update schedules, and exchange information. Following the meetings the CxA will periodically walk the building to observe HVAC, mechanical, and electrical equipment locations with respect to accessibility and general workmanship. When necessary the CxA will distribute a summary of information discussed to each team member within seven (7) days following the meeting.
2. Schedule: The Cx Progress Meetings shall be scheduled by the CxA during the Construction and Acceptance Phases as needed.
3. Attendees: Any Cx Team member is eligible to attend. Required attendees may vary depending on the items being discussed and will be identified in the meeting invitation.

F. Final Commissioning Meeting

1. Description: The Final Cx Meeting shall present and discuss the Cx Report.
2. Scheduling: The Final Cx Meeting shall be conducted after all FPTs have been successfully executed and all Issues are closed. At the Owner's discretion, the Final Cx Meeting may be dropped in favor of a conference call, or written project summary.
3. Attendees: Any Cx Team member is eligible to attend. The CxA may indicate additional required participants for the Final Cx Meeting during the course of the Project. Required attendees include:
 1. CxA (lead);
 2. GC;
 3. MC, EC, CC, and TAB representatives;
 4. EOR;
 5. Owner's Representative;
 6. Operators;
 7. Energy Management Technicians

IX. COMMISSIONING DOCUMENTATION

A. Owner's Project Requirements (OPR)

1. Definition: Document written by the owner that details the functional requirements of the project and the expectations of how it will be used and operated.
2. The OPR will include the following:
 1. Key Owner's Project Requirements
 2. General Project Description
 3. Objectives
 4. Functional Uses
 5. Occupancy Requirements
 6. Budget Considerations and Limitations
 7. Performance Criteria
 8. Project Goals
3. The CxA shall review the existing OPR at the beginning of the Cx process. The design documents shall be reviewed to ensure they are consistent with the OPR. When the design documents differ from the OPR the CxA shall coordinate with the project team to determine whether the design documents or OPR need to be revised.

B. Basis of Design (BOD)

1. Definition: Document written by the EOR documenting the major thought processes and assumptions behind the HVAC design decisions made to meet the OPR as they relate to the HVAC system.
2. The BOD will include the following:
 1. Applicable Codes and Standards
 2. Geographic and Climactic Conditions
 3. Facility Use Assumptions
 4. O&M Expectations
 5. Performance Criteria with regard to the OPR
 6. Design Methodology
 7. HVAC System Narrative

C. Commissioning Plan

1. Definition: Document outlining the organization, team member responsibilities, allocation of resources, and documentation requirements of the Cx Process.
2. Design Phase: The Cx Plan is initially written and issued by the CxA during the Design Phase.
3. Construction Phase: At the start of the Construction Phase, the Responsible Parties List, project description, commissioned systems list, and communication protocol sections are updated. Additional changes to the plan are made where necessary.
4. Acceptance Phase: At the end of the Acceptance Phase, the Cx Plan is updated to reflect the Cx team, equipment, and procedures actually used on the job. This final version of the Cx Plan shall be included in the Systems Manual which will be submitted to the Owner.

D. Issues Log

1. Definition: A formal and ongoing record of issues and their resolutions. Issues may include deviations from contract requirements, equipment problems, installation issues, control issues, and/or recommendations for system improvements. These issues can be generated by any CX Team member but can only be closed by the CxA,
2. The Issues Log includes the following information:
 1. **ISSUE #**: To help facilitate referencing and tracking issues.
 2. **DATE OF DISCOVERY**: The Cx Event where Issue was discovered and the associated date.
 3. **DESCRIPTION**: Description of specific Issue noted, including equipment designations and equipment settings.
 4. **RESPONSIBLE PARTY**: Party responsible for performing corrective action or providing information for resolution.
 5. **RESOLUTION/ STATUS UPDATE**: Initial entry will include CxA recommendation for resolution. Subsequent entries will detail actions taken to resolve the issue.
 6. **REINSPECTION DATE**: Date resolution will be verified by the CxA. Dates will be based on project deadlines and required tasks.
 7. **STATUS (OPEN/CLOSED)**: Both Open and Closed Issues remain on the Issues Log. Issues shall be closed by CxA when resolution has been confirmed or Owner indicates current status is acceptable.
 8. **DATE RESOLVED**: Date Issue is closed.

3. The Issues Log will be distributed as described in Section VII - Coordination and Communication. Additionally, the Issues Log shall be provided to any member of the Cx Team upon request.
4. Inclusion of an item in the Issues Log shall not be considered as direction to proceed on items not already contractually required. The CxA has no authority to direct work or authorize change orders.
5. The party responsible for performing the corrective action will be determined by the project contract requirements. Direction to proceed with the resolution can be given by the Owner, Architect, or Contractor, as allowed in the contract.

E. Submittals:

1. The CxA will review submittals affecting systems
 1. The submittal process for the shop drawings shall be as follows:
 - a. The GC shall submit electronic copies of the specified MEP submittals to the Architect.
 - b. The Architect forwards the specified MEP submittals (see Table 3.1 Commissioned Systems) to the EOR and the CxA.
 - c. The CxA reviews the submittals. The CxA sends an electronic copy of the submittal review form to the Architect and EOR via e-mail.
 - d. The EOR shall review the submittals simultaneously and incorporate the CxA's comments where applicable. Unless the Cx comments are included in the EOR comments, the Cx comments are not contractually binding. The EOR will return a copy of the reviewed submittal with all comments to the Architect.
 - e. A copy of the finalized submittal shall be sent from the Architect to the CxA.
 2. Shop Drawings are required for all Commissioned Equipment/Systems (as listed in Table 3.1) unless otherwise specified.
 3. The submittal process for Cx specific submittals shall be as follows:
 - a. The GC provides the Architect with an electronic copy of each specified Cx submittal.
 - b. The Architect forwards the submittal to the CxA.
 - c. The CxA reviews the submittals. Then, the CxA sends the review comments to the Architect.
 4. The following Cx submittals are required, in addition to the Shop Drawings listed above:

- a. Draft versions of equipment Start-Up Documents developed by the Contractor, along with the manufacturer's startup procedures (and factory tests if applicable).
- b. TAB Strategies and Procedures Plan including sample TAB forms.
- c. Completed Start-Up Documents
- d. Completed Pre-Functional Checklists
- e. Test Reports (including duct testing, pipe testing, ground testing, etc)
- f. Equipment and system warranties.

F. Start-Up Forms and Pre-Functional Checklists

1. The Contractor shall submit manufacturer-specific startup procedures/checklists and/or contractor start-up checklists and pre-functional checklists for review by the CxA.
2. The CxA will review the contractor's proposed start-up documents, and note items that must be added to provide a complete Pre-Functional Checklist and Start-up Form set.
3. The updated Pre-Functional Checklists and Start-Up Forms are completed and signed by the Contractor during Start-Up. The completed Start-up Documents are then submitted to the CxA and other members of the Cx Team.
4. In the event of equipment or systems tested and started at the factory, a Certification Letter from manufacturer shall be submitted.

G. Functional Performance Test (FPT) Documents

1. FPTs shall be developed by the CxA during the Construction Phase after the applicable Shop Drawings have been reviewed by the CxA and approved by the EOR.
2. Once the draft FPTs have been written, the CxA will forward electronic copies of the procedures to the GC. The GC shall forward them to all applicable Sub-Contractors.
3. The applicable Contractors shall review the FPTs to understand the required testing and their roles and responsibilities.
4. The CxA shall forward FPTs to any Cx Team member upon request. Throughout the Cx process, the CxA shall maintain a current record of the testing procedures.

H. Training Plan

1. The Training Plan shall outline the Owner Equipment Training and Final Systems Operation Training Events as proposed by the Contractor, and

shall be approved by the Architect and EOR and reviewed by the CxA. The CM will compile the individual training agendas of the Contractors and vendors and submit a comprehensive Training Plan to the CxA, Architect, and the Owner for review. Training Plan shall summarize all equipment and systems-related training events with topics to be covered and approximate training duration.

2. The Training Plan shall include at a minimum:
 1. Topic and applicable specification section;
 2. Scheduled date(s) for the Events(s);
 3. Location and setting (classroom or field);
 4. Lead Instructor and instructors qualifications;
 5. Co-instructors and their qualifications;
 6. Event outline or agenda;
 7. Anticipated duration;
 8. The attendees required for each session.

I. Operation and Maintenance Documentation Set

1. O&M Manual Requirements:
 1. Section 01 77 00, CLOSEOUT PROCEDURES provides general requirements for the O&M Documentation Set for Work across all Divisions.
 2. Other Division 22 Sections, Division 23 Sections, Division 26 Sections, and Other Sections requirements for O&M-related materials for equipment specified under individual Sections shall be as specified.
2. Responsibility: The CxA is responsible for reviewing the final O&M Documentation Set.

J. Commissioning Report

1. The purpose of this report is to summarize the activities and results of the Commissioning Process.
2. The Commissioning Report will include the following sections:
 1. Executive summary
 2. Project background and scope of the commissioning project
 3. Overview of activities conducted

4. Recommendations for future projects
5. Lessons Learned

K. Training Plan

1. The Training Plan shall outline the Owner Equipment Training and Final Systems Operation Training Events as proposed by the Contractor, and shall be approved by the Architect and EOR and reviewed by the CxA. The CM will compile the individual training agendas of the Contractors and vendors and submit a comprehensive Training Plan to the CxA, Architect, and the Owner for review. Training Plan shall summarize all equipment and systems-related training events with topics to be covered and approximate training duration.
2. The Training Plan shall include at a minimum:
 1. Topic and applicable specification section;
 2. Scheduled date(s) for the Events(s);
 3. Location and setting (classroom or field);
 4. Lead Instructor and instructors qualifications;
 5. Co-instructors and their qualifications;
 6. Event outline or agenda;
 7. Anticipated duration;
 8. The attendees required for each session.

X. PRE-FUNCTIONAL CHECKLISTS, TESTS AND STARTUP

A. Pre-Functional Tests

1. Contractor shall use the approved Start-up Documents identified in the Commissioning Documentation Section of this Plan.
2. Execution of Pre-Functional Checklists
 1. Contractors are responsible for completing the Start-up Documents and all associated pre-functional testing per contract documents and the Cx Plan.
 2. Only individuals having direct knowledge of a line item being completed shall check or initial the forms.
 3. Master copies of the Start-up Documents shall be collected by the GC. Contractors and vendors shall execute each checklist and tests and fill out and sign the master copy. The master copy shall include original

signatures. Once all equipment start-ups have been completed, the complete set of Start-up documents shall be submitted to the CxA for review.

3. Deficiencies and Non-Conformance
 1. The Contractor shall generate a Deficiency List with any outstanding items that were not completed upon initial testing. The Deficiency List shall be sent to the CxA within two (2) days of initial testing. Installing Contractors shall correct all areas that are deficient or incomplete.

B. Start-up Procedure

1. Mechanical start up procedure and tests are generally performed as a quality control measure to ensure manufacturer and project specifications were met during installation and start up of the equipment and/or system prior to bringing the equipment online and starting FPTs.
2. The parties responsible for each part of startup and initial checkout are identified in the contract documents.
3. Execution of Startup
 1. Equipment start-up shall be conducted and documented per contract documents and the Cx Plan.
 2. The Contractor designated to develop the Start-up Forms will obtain manufacturer installation, start-up, and checkout data, including original field checkout sheets completed by the field technicians.
 3. The Contractors and vendors shall execute the start-ups in accordance with the manufacturer instructions and submit a signed copy of the completed start-up reports to the CxA.
4. Deficiencies and Non-Conformance
 1. The Contractors shall clearly list any outstanding items of the initial start-up that were not completed. The start-up form and deficiencies list shall be provided to the CxA within two (2) days of test completion. The installing Contractors or vendors shall correct all areas that are deficient or incomplete.

C. Controls Checkout and Operational Verification

1. The Controls Contractor shall comply with all requirements for Coordination with the CxA and Execution of System Testing included in specification sections 23 09 13 INSTRUMENTATION AND CONTROL FOR HVAC.
2. All CxA required control pre-functional checklists and equipment start-ups shall be completed and reviewed by the CxA prior to TAB. The CC shall execute the tests and trend logs assigned to them by the CxA and remain on site for assistance for mechanical system functional tests

XI. TEST, ADJUSTMENT, AND BALANCE (TAB)

1. TAB shall be conducted in accordance with specification section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
2. The CxA shall review the TAB Contractor Submittal: TAB Strategies and Procedures Plan.
3. TAB work shall not begin until the Pre-Functional Tests are complete and the TAB Strategies and Procedure Plan has been approved.
4. The CxA will perform TAB verification with the TAB contractor after the initial pencil copy of the balance report has been submitted. Readings from the balance report will be verified through sampling in accordance with contract requirements (see Table 3.1 for testing requirements).
5. A final TAB report shall be submitted to the CxA and EOR for review.

XII. FUNCTIONAL PERFORMANCE TESTS (FPT)

A. Prerequisites

1. All equipment, components and devices associated with the test must be started and startup must be documented. This includes, but is not limited to,
 1. Completed Start-up Documentation;
 2. Pressure testing of equipment, duct, and pipes;
 3. Flushing/cleaning of applicable systems;
 4. Completed labeling and identification;
 5. Completed insulation of applicable systems;
2. Start-up Reports, Pre-Functional Checklists, and TAB Reports are submitted to and reviewed by the CxA.
 1. CxA shall verify that all required documentation has been submitted and is per the contract requirements.
 3. Trending Reports are submitted prior to the start of FPTs. (Additional trending is also required after the completion of FPTs to ensure sequences were adjusted properly and to verify proper operation over an extended period of time).
 4. Unless specifically agreed to by the Owner and CxA, all support systems shall be completed prior to the FPTs.
 1. Example: Air Handler:
 - a. Electrical system serving the AHU is completed and tested.

- b. Hydronic systems are balanced and have passed pre-functional tests.
 - c. Air side balancing is complete
 - d. Controls are fully installed and operational.
5. The CxA shall determine the sequence of testing.

B. General

1. The items listed in this section are general FPT requirements that apply to typical equipment, systems, sub-systems, and components.
 1. During the FPTs, submittal documentation shall be convenient to testing area.
 2. Trends shall be set up for each piece of commissioned equipment as outlined in the contract documents and per CxA request. The CxA shall provide Trending Request Forms outlining the trending data and intervals required for each system.
 3. Sensors associated with the tested equipment and systems shall be verified.
 4. All equipment and systems safeties shall be tested. All dynamic systems powered by electricity shall be tested to simulate a power outage to ensure proper sequencing upon return of power.
 5. All sequences of operation shall be tested. Sequences tested will be based on the approved BAS submittal language.
 6. Problems or discrepancies discovered during FPTs shall be noted in the test documents and added to the Issues Log.
2. The CxA shall prepare itemized testing plans and procedures that will:
 1. Specify individual tests and procedures that meet the general requirements of this plan.
 2. Serve to document and record the testing procedures and the results of the tests.

C. Instrumentation

1. Proprietary instrumentation required to verify performance of specialty equipment shall be provided by the Contractor and made available to the CxA. Generally, no testing equipment will be required beyond that necessary to perform Contractor's work under these Contract Documents.
2. All equipment used for testing and calibration shall be NIST/NBS traceable and calibrated with the preceding 6 month period. Certificates of calibration shall be submitted.

D. Factory Startups

1. Some systems and equipment may require factory startups. These systems will generally be reviewed and checked during the FPTs. All costs associated with the factory startups are included with the bid unless otherwise noted. The GC shall notify the witnessing parties of the factory startup schedule. Cx Team members may witness any of these startups at their discretion, or as required by the contract scope. Aspects of FPT accomplished during the factory startup may be reviewed by the members of the Cx Team to judge if they meet the intent of the FPT.

XIII. PROJECT CLOSEOUT

A. Prerequisites

1. The project is complete when the following items are complete:
 1. Issues on the Issues Log must be closed
 2. All FPTs must be complete and correct

B. Deliverables

1. Cx Systems Manual
2. Ten month Post-Occupancy Report

SECTION 02 4119
SELECTIVE DEMOLITION

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. Demolition and removal of selected architectural elements.
 - 2. Salvage of existing items to be reused or recycled.
- B. Related Requirements:
 - 1. Section 01 1000 "Summary" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.
 - 2. Section 01 5000 "Temporary Facilities and Controls" for requirements impacting existing Work
 - 3. Section 01 7300 "Execution" for requirement for existing land surveys, below-grade geospatial structure and utility location data requirements and format for integration into design team Building Information Model
 - 4. Section 01 7419 "Construction Waste Management" for disposal of demolition waste

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner.
- C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.5 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at Project site.
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.

3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and , for noise control. Indicate proposed locations and construction of barriers.
- C. Schedule of Selective Demolition Activities: Indicate the following:
 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 3. Coordination for shutoff, capping, and continuation of utility services.
 4. Use of elevator and stairs.
 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- D. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.
- E. Predemolition Photographs or Video: Submit before Work begins.
- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- G. Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.9 FIELD CONDITIONS

- A. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- B. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

- C. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- D. Storage or sale of removed items or materials on-site is not permitted.
- E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.
- C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.
- E. Engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
 - 1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- F. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs and preconstruction videotapes.
 - 1. Comply with requirements specified in Section 013233 "Photographic Documentation."
 - 2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
 1. Comply with requirements for existing services/systems interruptions specified in Section 01 1000 "Summary."
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 2. Arrange to shut off indicated utilities with utility companies.
 3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - c. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - d. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - e. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
- C. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 1. Comply with requirements for access and protection specified in Section 01 5000 "Temporary Facilities and Controls"

3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and

- chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
 5. Maintain adequate ventilation when using cutting torches.
 6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 9. Dispose of demolished items and materials promptly. Comply with requirements in Section 01 7419 "Construction Waste Management and Disposal."
- B. Removed and Salvaged Items:
1. Clean salvaged items.
 2. Store items in a secure area until delivery to Owner.
 3. Transport items to Owner's storage area designated by Owner.
 4. Protect items from damage during transport and storage.
- C. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.
- 3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS
- A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least **3/4 inch (19 mm)** at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
- B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.
- C. Stone: Remove stone along mortar joints to preserve stone units intact for quantity indicated on Drawings to be preserved for integration into design
- D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 4. Comply with requirements specified in Section 01 7419 "Construction Waste Management and Disposal."
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.7 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.8 SCHEDULE OF SALVAGE ITEMS

- A. Salvage items as indicated on the drawings and noted here:
 - 1. Existing cork flooring
 - 2. Existing church pews.
 - 3. Existing stained glass window.

END OF SECTION

SECTION 024119 - SELECTIVE DEMOLITION

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. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 015639 "Temporary Tree and Plant Protection" for temporary protection of existing trees and plants that are affected by selective demolition.
3. Section 017300 "Execution" for cutting and patching procedures.
4. Section 013516 "Alteration Project Procedures" for general protection and work procedures for alteration projects.
5. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade improvements not part of selective demolition.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and store.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at [Project site] <Insert location>.
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - 5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Engineering Survey: Submit engineering survey of condition of building.
- C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
- D. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- E. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before Work begins.
- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that

recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

- G. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.9 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
 - 1. Before selective demolition, Contractor will remove selected items by owner.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. Hazardous materials will be removed by Owner before start of the Work.
 - 2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Hazardous Materials: Present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
 - 1. Hazardous material remediation is specified elsewhere in the Contract Documents.
 - 2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
 - 3. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.

- F. Historic Areas: Demolition and hauling equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches or more.
- G. Storage or sale of removed items or materials on-site is not permitted.
- H. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.10 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.
- B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.11 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

- C. Engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
 - 1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
- E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- F. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs or video.
 - 1. Comply with requirements specified in Section 013233 "Photographic Documentation."
 - 2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
 - 3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. Arrange to shut off utilities with utility companies.
 - 3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

- b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
- c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
- g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
 - 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 - 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction.

- Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 5. Maintain fire watch during and for at least 2 hours after flame-cutting operations.
 6. Maintain adequate ventilation when using cutting torches.
 7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 10. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Work in Historic Areas: Selective demolition may be performed only in areas of Project that are not designated as historic. In historic spaces, areas, and rooms, or on historic surfaces, the terms "demolish" or "remove" shall mean historic "removal" or "dismantling" as specified in Section 024296 "Historic Removal and Dismantling."
- D. Removed and Salvaged Items:
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.
- E. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- F. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
- B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.
- C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.
- E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.
- F. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight.
 - 1. Remove existing roof membrane, flashings, copings, and roof accessories.
 - 2. Remove existing roofing system down to substrate.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction and recycle or dispose of them according to Section 017419 "Construction Waste Management and Disposal."
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- B. Burning: Do not burn demolished materials.

3.8 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.9 SELECTIVE DEMOLITION SCHEDULE

- A. Coordinate and provide a schedule of demolition items to owner.

END OF SECTION 024119

SECTION 03 1100
CONCRETE FORMING

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS: The General Conditions, any Supplementary General Conditions and Division 1, General Requirements, are hereby made a part of this Section as fully as if repeated herein.
- 1.2 SECTION INCLUDES
- A. Job-Built Formwork, Prefabricated Forms, Form Ties and Accessories; Design; Construction and removal of forms, including shoring, bracing, cribbing, and screeds.
1. Embedded Items: Provide accurate setting and placing of items built into the concrete to provide openings, recesses, attachment, or anchorage. Certain products are to be furnished as a part of this Contract and are specified in other sections.
 2. Formwork Design: Contractor shall hire a registered professional engineer who shall be responsible for the design of all temporary formwork including stripping procedures for concrete flat slabs, walls, columns, etc.
- 1.3 RELATED WORK
- A. Sections of DIVISION 3, CONCRETE, as well as all other sections involving interface with concrete work.
- 1.4 QUALITY ASSURANCE
- A. References: Comply with the following minimum standards:
1. ACI-347R94 (ANSI A 145.1) Recommended Practice for Concrete Formwork.
 2. ACI-318-95 (ANSI A 89.1) Building Code Requirements for Reinforced Concrete
 3. ACI-301-96 (ANSI A 138.1) Specification for Structural Concrete for Buildings.
 4. ACI-117-90 Standard Specifications for Tolerances for Concrete Construction and Materials.
 5. ASTM E-1155 Standard Method for Determining Floor Flatness & Levelness Using the F-Number System.
 6. ACI 302.1 R89 Guide for Concrete Floor and Slab Construction.
- 1.5 QUALITY CONTROL SUBMITTALS
- A. Certification: Form release materials will not discolor concrete and without removal from concrete are compatible with materials to be used for setting materials, adhesives, applied finishes, and coatings.
- 1.6 JOB CONDITIONS
- A. Design Loads: Do not place, handle or store products, equipment or other materials on structure, before concrete has reached its design strength and in such a manner as to not exceed design loads. Check with Structural Engineer for design loads of each area and review of construction loads. Any area damaged by construction operations must be repaired or replaced at no costs.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

- A. Lumber: Western Wood Products or Southern Forest Products grading. Common or Utility grades for non-exposed surfaces. Structural or Construction grades for walers, braces and supports.
- B. Plywood: US Product Standard PA-1 "B-B (Concrete Form) Plywood" Class I, exterior grade or better, milled oiled and edge sealed, with each piece bearing legible inspection trademark.

2.2 ACCESSORIES: Furnish hairpin clips, bands, clamps, braces, adjustable shoring jacks, fasteners, form ties, etc., necessary to execute installation of formwork. No aluminum devices or fasteners (including nails) will be permitted.

- A. Form Ties: Non-corrosive, non-staining; minimum working strength as required by concrete sections being contained when full liquid concrete and construction loads; adjustable in length to permit complete tightening of forms and of such types as to leave no metal closer than 1-1/2" the surface, spacing as required to maintain formwork and finish concrete within tolerances and at a uniform spacing approved by the Architect, generally 24 inches on center.
- B. Form Release: Non-staining liquid which will impart a waterproof film to prevent adhesion of concrete and will not stain, cause imperfections, or leave a paint-impeding coating on the face of the concrete. When finished surface is to be painted or to receive other surface treatment, the material applied to form surfaces shall be compatible with the type of paint or surface treatment to be used.

PART 3 - EXECUTION

3.1 DESIGN: Formwork and its supports shall carry adequately all liquid concrete, men, and equipment, in absolute safety under loads imposed during construction.

- A. Design and Placement of Forms: ACI 347, Chapter 2: Design and ACI 318, Chapter 6: Formwork, Embedded Pipes, and Construction Joints.
- B. Tolerances: ACI-347 paragraphs 3.3 and 3.4, and ACI 117 will be considered absolute maximum, unless otherwise indicated.

3.2 CONSTRUCTION: Construct forms to slopes, lines and dimensions shown, plumb and straight and sufficiently tight to prevent leakage; securely brace and shore forms to prevent displacement and to safely support construction loads. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages, inserts and other features required in work.

- A. Forms for exposed finish concrete shall be furnished in the largest practicable sizes to minimize the number of joints and to conform to the joint system shown on the drawings.

3.3 BUILT-IN EMBEDDED ITEMS: Provide for installation of fastening devices required for attachment of other work. Properly locate in cooperation with other trades; secure and maintain in position before concrete is poured.

- A. Coordination: Ascertain requirements and extent, location and details of items to be embedded or built into concrete. Templates or setting diagrams shall be furnished by the various trades or manufacturers when items are to be set, embedded or blocked -out by this trade. Ensure that anchors reach adequate penetration and engage with reinforcement.

Temporary support shall not be evident when forms are removed.

- B. Work by Others: Allow sufficient time between erection of forms and placing of concrete for various trades to properly set embedded items required for their work. Maintain in position and protect all (provided and placed in the forms by the various trades) until concrete is completed.
 - 1. Conduits: Cannot be run in the concrete.
- C. Anchorages: Items required to be set as a part of this work generally include: Inserts, sleeves, hangers, ties, anchors, bolts, base & leveling plates, frames, angle guards, dowels, anchor slots, reglets, nailing strips, blocking, grounds, sleepers, and adjustable wedge inserts. Refer to Miscellaneous Metals and Masonry Sections for certain products.
 - 1. Accurately locate utilizing a level or transit. Set in position with proper penetration, exposure and engagement with reinforcement. Maintain in position by double bolting to formwork or wood templates.
 - 2. Plates, Frames, Sleeves, Blocking and Miscellaneous Metals: Set item with perimeter flush with concrete surface. Ensure adequate bonding, anchorage and protection of dissimilar materials. Items shall have a thickness of not less than 1/8" (i.e. no cans, cups, etc.) Prevent leakage and infiltration of mortar into openings.
- 3.4 LINES AND LEVELS: Check the lines and levels of the completed formwork for all exposed columns, grade beams, walls, etc., before concrete is placed. Make whatever corrections or adjustments to the formwork to correct any deviations which exceed specified tolerances allowed.
- 3.5 CLEANING FORMWORK: Force debris to and out of clean-out panels with a jet stream of compressed air. Clean-out all debris. Hose form thoroughly with water and air-jet out any standing water when weather permits.
 - A. If concrete placing does not commence immediately after cleaning, cover openings in forms with tarpaulins.
- 3.6 FORM REMOVAL: Remove forms in accordance with ACI 301, Paragraphs 2.3.3 and 2.3.4; ACI 318 paragraph 6.2, and ACI 347 paragraphs 3.7 and 3.8. Removal strength of concrete for stripping shall be determined in accordance with ACI 301, paragraph 4.7.
 - A. Appearance: No steel spreaders, ties, or other metal, shall project from or be visible on any concrete surface.
 - B. Shoring: Leave shoring in place until concrete member will safely support its own weight, plus any loads that may be placed upon it. Any reshoring done must meet the requirements of ACI 347.

END OF SECTION

SECTION 03 1500
CONCRETE ACCESSORIES

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS: The General Conditions, any Supplementary General Conditions and Division 1, General Requirements, are hereby made a part of this Section as fully as if repeated herein.
- 1.2 SECTION INCLUDES
- A. Construction joints, expansion joints and control joints.
 - B. Vapor retarders under all interior concrete slabs on grade.
- 1.3 RELATED WORK
- A. Section 03 1100 Concrete Forming.
 - B. Section 03 3000 Cast-In-Place Concrete.
- 1.4 REFERENCES
- A. ASTM - American Society for Testing and Materials
 - B. ASTM A 924 – Specification for General Requirements for Steel Sheet Metallic Coated by the Hot Dip Process
 - C. ASTM C 578 - Specification for Preformed, Cellular Polystyrene Thermal Insulation
 - D. ASTM E 1745 - Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
 - E. ASTM E 1643 - Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
- 1.5 SUBMITTALS
- A. Manufacturers' Literature: Indicate compliance with product specifications.
 - B. Samples: Each type product with accessories, if requested.
 - C. Shop Drawings: Indicate proposed locations of all construction joints, and pouring sequence.
 - D. Manufacturer's standard labor and material warrantee for all joint sealant material which states that the product will be free of all defects (including workmanship) for a period of 5 years from the completion of the project. This includes all future labor and material deemed necessary to repair the sealant if any future cracks or leaks occur.

PART 2 - PRODUCTS

2.1 EXPANSION JOINT FILLERS

- A. Expanded Polystyrene: Closed-cell, extruded polystyrene with high density skin.
 - 1. ASTM D-3575
 - 2. Density = 2.0 pcf
 - 3. Compressive Set (25%) = 40 psi.
 - 4. Water Absorption = 1% maximum
 - 5. Manufacturers:
 - a. "Deck-O-Foam" by W.R.Meadows
 - b. "Foamtastic" by Hohmann & Barnard

2.2 JOINT SEALANTS

- A. Polyurethane: One or two component, polyurethane joint sealant, Non-Sag conforming to F.S. II-S-227E. Color as selected by the Architect.
 - 1. Manufacturers:
 - a. Sonneborn - Sonolastic NP I
 - b. Sika Chem. Co. - Sikaflex 1a; 2c-NS/SL
 - c. Tremco - Dymeric
 - 2. Locations: All exposed joints.

2.3 CONTROL JOINTS

- A. Sawcut control joints made with a wet saw.
 - 1. Locations: All interior concrete slabs on grade.

2.4 VAPOR RETARDER

- A. Provide vapor retarder cover over prepared base material where needed to prevent rapid escape of moisture into subbase and where indicated. Use only materials which are resistant to decay when tested in accordance with ANSI/ASTM E-154, as follows:
 - 1. Polyethylene sheet not less than 6 mils thick.

PART 3 - EXECUTION

3.1 JOINT ARRANGEMENTS

- A. Location Criteria: Locate as to least impair the strength of the structure, and at locations coincident with designed structural and architectural features (specifically column lines). Maximum horizontal dimensions of a single unit of placement, 30 feet in a straight line (except footings).
 - 1. Locations: All locations are subject to approval.
- B. Joint Design: Follow a plane perpendicular to the principal reinforcement with a bulkhead shaped to produce a keyed surface except of expansion joints.
- C. Pouring Sequence: Continuous pouring between joints; however, do not place concrete in adjacent sections until 48 hours have elapsed from placement of original sections.

3.2 CONSTRUCTION JOINTS

- A. Framed Concrete Slab Surfaces: Roughen joint surfaces with a chipping hammer or by another approved method which will remove laitance, loose particles or aggregate, or damage concrete. After the surface of the joint has been cleaned of dust, chips, or other foreign material, an approved bonding agent (as specified in Section 03 3000) shall be placed on the joint surface prior to placing the next lift of concrete.
- C. Slab On Grade Construction Joints: Establish longitudinal and transverse control joints. With elevations checked by instrument stretch line over entire length. Drive stakes 2 ft. o.c. and attached screed to stakes. Provide lateral support where used as a bulkhead. Install smooth dowels and locate joints as specified in the contract documents.
 - 1. Locations: As indicated on the drawings, or if not shown, locate joints at 40'-0" o.c. maximum spacing for all concrete slabs on grade.
- D. Doweling and Keying: All formed construction joints shall be doweled. Provide keys, dowels or other details at construction joints as indicated.

3.3 EXPANSION JOINTS

- A. Exposed slabs: Place joint filler 1/2 inch below the finished surface of the slab and extend to the bottom of the slab. The joint between the top of the filler and the finished slab shall be filled with a joint sealer.
 - 1. Locations: Where indicated. If not shown, divide exterior walkways into areas not exceeding 150 sq. ft.
 - 2. Type and Size: Use 1/2" thick expanded polystyrene type expansion joint filler or other thickness indicated for full width of concrete section.

3.4 CONTROL JOINTS

- A. Concrete Slabs: Install control joints in slabs on grade and exterior walkway slabs as indicated on the drawings, or if not shown, locate joints at 20'-0" o.c. maximum spacing for interior slabs on grade and at 5'-0" o.c. for exterior walkway slabs.
 - 1. Type and Size: Concrete slabs shall have 1/4" wide sawcut joints installed 1/4 of the slab depth below the top surface within 8 hours of pouring slab.

3.5 INSTALLATION OF FILM TYPE VAPOR RETARDERS FOR CONCRETE SLABS

- A. Ensure subbase for concrete is compacted; sharp objects and scraps are removed.
- B. Place vapor barrier in widest practical widths with all joints lapped minimum 6 inches. Seal vapor barrier overlap together with Raven Vapor Bond Tape.
- C. Positioning: Maintain in place. Stretch and weight edges and laps to maintain their position until concrete is placed.
- D. Protection and Patching: Protect vapor barrier from rips. Hold patches in readiness during the concrete pouring operation and lay over all rips (beneath wire fabric and reinforcing steel.)
- E. Penetration: (Pipe, anchors, and other items) Seal vapor barrier material to the pipe and other

penetrations with an elastomeric sealant that is approved by the vapor barrier manufacturer and architect.

3.6 JOINT SEALANTS

- A. The surfaces to receive the sealant shall be cleaned of any loose materials, dirt, dust, laitance, etc. Cleaning shall be done by power wire brushing followed by blasting with oil-free compressed air. No cleaning solvents shall be used.
- B. Install polyurethane sealant 1/8" below edges of the adjacent concrete per the manufacturer's recommendations. In areas where the joints have been overfilled, remove excess while still fluid or remove after hardening by grinding.
- C. Where the depth of the joint appears excessive, the depth of the polyurethane sealant may be limited to 0.5" by installing closed cell backer rod and non-bonding tape.
- D. Follow manufacturer's recommendations covering the proper method of curing the sealant. Prevent any contact with sealant before it has cured.
- E. Make test applications to insure that proper adhesion is being attained. If not, determine what additional steps are needed to provide it.
- F. Following the completion of the work, the Architect shall inspect the joints. Where the smoothness of the joint is determined to be unsatisfactory, the contractor shall grind down the surface of the joint to make it acceptable.

END OF SECTION

SECTION 03 2000
CONCRETE REINFORCEMENT

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS: The General Conditions, any Supplementary General Conditions and Division 1, General Requirements, are hereby made a part of this Section as fully as if repeated herein.
- 1.2 SECTION INCLUDES
- A. Steel reinforcing bars, ties, dowels and welded wire fabric, miscellaneous reinforcement and accessories.
- 1.3 RELATED WORK
- A. Sections of DIVISION 3, CONCRETE, as well as all other sections including interface with concrete work.
- 1.4 QUALITY ASSURANCE
- A. References: Conform to and perform work in accordance with the current editions of:
1. Local and State Building Codes.
 2. "Building Code Requirements for Reinforced Concrete", ACI 318-95.
 3. "Manual of Standard Practice for Detailing Reinforced Concrete Structures", ACI 315, and CRSI 63 and CRSI 65.
 4. Specifications for Structural Concrete Buildings ACI 301.
 5. ANSI/AWS D1.4 Welding Code.
- B. Manufacturing Source: Reinforcing Steel of domestic origin.
- C. Fabricator: Maintain a competent engineering department and adequate equipment to fabricate steel in accordance with CRSI Manual of Standard Practice, latest edition.
- 1.5 SUBMITTALS
- A. Shop Drawings: Show plan layouts (including dimensioned slab openings), elevation drawings, bending, splicing, sizes, spacing and details of all reinforcing and accessories.
Please note that the Contract Documents in CADD format will not be made available to the contractor for their use in the preparation of the shop drawings, unless a release is signed, and a fee is paid for each cadd file requested.
- B. Reports and Results: From inspection and testing as soon as determination is made.
- 1.6 PRODUCT HANDLING
- A. Packing: Reinforcement must be tagged as required to indicate respective mill test and job condition.
- B. Storage and Handling: Protect products in such a manner as to prevent damage, bending, or undue rusting. Store at site to permit easy access for proper inspection and identification of

each shipment. Separate material of each shipment for size and shape.

PART 2 - PRODUCTS

- 2.1 REINFORCING: Manufacture and deform in accordance with ANSI/ASTM A-615, except all reinforcing to be welded shall conform to ASTM A-706. All rebar shall consist of domestic manufacture billet steel of clean, new stock.
- A. All Bars: Use Grade 60 (yield) min. 60,000 psi.
- 2.2 WELDED WIRE FABRIC: Manufacture in accordance with ANSI/ASTM A185.
- A. Unless otherwise specified in the contract documents, provide 6"x 6"-W.2.9 / W2.9 W.W.F., Grade 65 (yield) min. 65,000 psi.
- 2.3 FASTENERS AND SPLICE
- A. Tie Wire: Double annealed steel wire, minimum #16 gauge, conforming to ANSI/ASTM A497.
- 2.4 ACCESSORIES: Provide all spacers, chairs, bolsters, ties and other devices necessary to properly place, space, support, and maintain reinforcement in locations. Provide in accordance with ACI-315. No aluminum inserts or accessories will be permitted.
- A. Bar Supports: Conform to "Bar Support Specifications", CRSI Manual of Standard Practice, Chapter 3, latest edition, and be of the following types:
1. Support reinforcing in footings with precast concrete blocks.
 2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).
 3. Support reinforcement for slabs on grade with precast concrete blocks, or No. 5 rebar placed on metal chairs with plate bases as required to prevent penetration of earth or vapor barrier. Spacing of blocks, chairs, and No. 5 rebar shall be as necessary to prevent sagging of the reinforcement under the weight of construction workers and wet concrete.
 4. Support reinforcement for framed slabs (including slabs poured on metal deck) with No. 5 rebar placed on slab bolsters or chairs spaced as necessary to prevent sagging of the reinforcement under the weight of construction workers and wet concrete.
- 2.5 FABRICATION: Shop fabrication according to approved shop drawings. All fabrication of bars performed in a shop, with field fabrication done only where unavoidable, and approved.
- A. Reference: Fabricate in accordance with CRSI Manual of Standard Practice for Reinforced Concrete Construction.

PART 3 - EXECUTION

- 3.1 INTENT: All concrete shall be reinforced. For conditions not specifically shown or detailed, framing and reinforcement shall be provided in a manner consistent with other similar details or conditions shown on the drawings. Prior to work under these conditions, notify the Architect for confirmation.
- 3.2 PREPARATION
- A. Clean bars of loose mill scale, rust, oil, and all coatings that will destroy or reduce the bond

before placing, and again before concrete is placed.

- B. Examine the drawings and specifications for all other Sections of Work, especially the mechanical and electrical work.

3.3 PLACEMENT OF REINFORCEMENT: Accurately place in positions and spacings shown. Securely support and fasten to prevent displacement before or during concrete placement. Place reinforcing steel, bar supports, and splice devices, in accordance with CRSI Manual of Standard Practice, latest edition; ACI 315 and ACI 318.

- A. Support: Use approved accessories to hold reinforcement at proper distances from surrounding surfaces, with minimum coverage as indicated. Tying reinforcing steel with wire to nails in forms or using wood spacers is not permitted.
- B. Spacing: In no case shall the clear distance between bars be less than 1 inch, nor less than 1-1/2 times the maximum size of coarse aggregate in the concrete, unless specifically indicated as bundled.
 - 1. Concrete Coverage and Protection: ACI-318.2.
 - 2. Clearance: The clear distance between bars also shall apply to the clear distance between contact splices and adjacent splices or bars.
- C. Layering: Where reinforcement in beams or girders is placed in two or more layers, the clear distance between layers shall not be less than 1 inch, and the bars in the upper layers shall be placed directly above those in the bottom layer.
- D. Field Adjustments: Move concrete reinforcing steel as necessary to avoid interference with other reinforcing steel, other embedded items; however prior to placing concrete, bars moved more than tolerances herein shall be inspected and approved.
 - 1. Sleeves and Embedded Items: Do not cut bars to clear sleeves or slots through slabs or walls. Wrap bars around these openings.
 - 2. Openings: Bar reinforcement terminated at openings in slabs and walls shall be compensated for by placing one half of reinforcement terminated on each side of openings for the full span length.
- E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.
- F. Minimum Rebar and Dowel Extent: Provide minimum temperature reinforcing in all walls and slabs where no reinforcing is shown or noted.
- G. Minimum Placement: All reinforcing steel must be in place, wired, and inspected, before depositing concrete.
- H. Protection: Protection care must be exercised in placing reinforcing steel to prevent any marring of interior faces of forms or shifting of forms.
- I. Provide protection for all vertical reinforcing bars that are not immediately enclosed by formwork.

3.4 FASTENING INTERSECTIONS: Wire tie reinforcement together at all points where bars cross. Splice as indicated. Welding or tack welding of reinforcement bars to other bars or to plates,

angles, etc. is prohibited. Work shall be performed in accordance with CRSI Recommendations.

- 3.5 LAP SPLICES: Lap bars as scheduled on drawings and securely tie with wire at frequent intervals. Stagger so that adjacent splices will be apart with care taken to maintain proper clearance, between parallel bars and between bars and forms. Make lap splices in a manner to provide laps consistent with structural drawings, and CRSI.
- A. Tie Wires: Cut loose ends and turn wire twists inside of the section and bend so that placement of concrete will not force ends to exposed concrete surfaces.
- 3.6 DOWELS: Install with a template to hold bars in the proper position, placed as located on the drawings.
- A. Size: Dowels shall be of the diameter size indicated in various sections with lengths equivalent to twice that required for the indicated spliced. One-half of the length shall be embedded with the required splice length exposed for attachment.
- 3.7 INSPECTION
- A. Comply with inspection requirements of Sections 01 4000, Quality Control, 03 3000 Cast in Place Concrete, and Division 4 Masonry.
- B. Inspect concrete and masonry reinforcement as indicated in ACI 301, Section 18, paragraph 18.4.1.2.
- C. Inspect reinforcing size, quantity, strength, position (location), and arrangement. Concrete and masonry reinforcement includes welded wire fabric, mild reinforcing bars, and fibrous types. Inspection shall include but is not limited to the following.
1. Insure rebar and welded wire fabric is not displaced during placement of concrete and masonry grout.
 2. Rebar size, quantity, strength, position (location) and arrangement in columns, beams, slabs, footings, walls, etc.
- D. Submit daily reports indicating conformance and exceptions of concrete operation to contract documents.
- E. See specification Section 03 3000 for further requirements.
- F. Final Report and Certification: The Inspection Agency shall prepare a written report that summarizes the work inspected during the course of the project. A discussion of all deviations from the contract documents and specifications, with their related impact on the final construction, shall be described in detail. The engineer of record shall review this final report, and recommend corrective measures (as deemed necessary) that must be made prior to final acceptance of the work. Prior to final payment, a written report certifying that the work meets the requirements of the contract documents, specifications, and all governing agencies shall be prepared, submitted, and approved by the Architect.

END OF SECTION

SECTION 03 3000

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS: The General Conditions, any Supplementary General Conditions and Division 1, General Requirements, are hereby made a part of this Section as fully as if repeated herein.
- 1.2 SECTION INCLUDES
- A. Cast-in-place concrete including preparation, conveying, placement, leveling, finishing, hardening, sealing, curing, bonding, jointing, cutting, patching and grouting.
 - B. Specific elements include foundations, walls, slabs, columns, stairs, etc.
- 1.3 RELATED WORK
- A. Sections of Division 3, Concrete, as well as all other sections involving interface with concrete work.
- 1.4 QUALITY ASSURANCE
- A. Manufacturer's Representation: Arrange with the manufacturer to provide a representative to assist and instruct the trades in the proper application of his product. The manufacturer's representative shall be available to visit the site if it becomes necessary for this purpose, and certification of application.
- 1.5 REFERENCES
- A. American Concrete Institute (ACI): The following constitute part of this specification. Reference to Portland Cement shall mean type and color specified.
 - 1. 318 (ANSI A89.1) - Building Code Requirement for Reinforced Concrete.
 - 2. 306 (ANSI A144.1) - Recommended Practice for Cold Weather Concreting.
 - 3. 305 - Recommended Practice for Hot Weather Concreting.
 - 4. 211.1 (ANSI A167.1) - Recommended Practice for Selecting Proportions/Normal Weight Concrete.
 - 5. 304 (ANSI A186.1) - Recommended Practice for Measuring, Mixing and Placing Concrete
 - 6. 301 (ANSI A138.1) - Specification for Structural Concrete for Buildings.
 - 7. 311 (ANSI A188.2) - Recommended Practice for Concrete Inspection.
 - 8. 302.1 Guide for Concrete Floor and Slab Construction.
 - 9. 117 Standard Specifications for Tolerances for Concrete Construction and Materials.
 - B. American Society of Testing and Materials (ASTM):
 - 1. C-150 - Portland Cement
 - 2. C-309 - Liquid Membrane - Forming Compounds for Curing Concrete
 - 3. E-1155 Standard Method for Determining Floor Flatness & Levelness Using the F-Number System.
- 1.6 SUBMITTALS
- A. Mix Designs: All classes of concrete include aggregate gradation and actual proportioning.

- B. Manufacturer's Literature: Each material and accessory include manufacturer's directions and product specifications with recommended unit quantities.
- C. Certification:
 - 1. Compliance: Notarized statement issued by manufacturers of the respective products that the supplied products meet requirements and are tested in accordance with standards specified.
 - 2. Compatibility: Certify that curing compounds, sealers and form release agents will not discolor concrete and without removal from concrete will not be harmful to later application of setting materials.
 - 3. Installation: Certify that the materials have been installed/applied in accordance with the manufacturer's instructions.
- D. Delivery Tickets: Duplicate tickets with each load; stating:
 - 1. Producer's Name; Delivery Date; Time Dispatched; Time Delivered; Truck Number; Number of Cubic Yards; Type and Brand of Cement; Amount of Admixture; Class of Concrete or Cement Content (Bags/Cubic Yards); Amount of Water Added at Job.
- E. Qualifications of inspection agency including past experience of field personnel to perform required inspection.
- F. Testing and Inspection Reports:
 - 1. Results of compression cylinders and grout cubes.
 - 2. Test Reports: Indicating strength and density of furnished product.
 - 3. Inspection reports: Certifying rebar and weld wire fabric placement, etc. (See Section 3.16 – Testing and Inspection).

1.7 PRODUCT HANDLING

- A. Storage: Store cements in dry, well ventilated enclosures.
- B. Do not use cement showing indication of moisture damage, caking and other deterioration.

1.8 ENVIRONMENTAL CONDITIONS

- A. Excess Moisture: Place no concrete during periods of rain, sleet or snow, unless adequate and approved protection is provided; allow no rain or other weather-produced moisture to increase mixing water or to damage finished surfaces.
- B. Cold Weather Concrete: ACI-306.
 - 1. Admixtures: Do not use salt, chemicals or other foreign materials mixed with the concrete for the purpose of preventing freezing.
 - 2. Ground freezing: Cover concrete slabs on earth, footings and walls, as required to protect the ground underneath from freezing.
 - 3. Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures by using insulating blankets or other approved method.
 - 4. When air temperature has fallen to or is expected to fall below 40 degrees Fahrenheit uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees Fahrenheit and not more than 80 degrees Fahrenheit at point of placement.

- C. Hot Weather Concrete: ACI-305. Prevent accelerated set from heat and winds. Maintain moist as required.
 - 1. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C-94 may be required.
 - 2. When air temperature is between 85 degrees Fahrenheit and 90 degrees Fahrenheit, reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 degrees Fahrenheit, reduce mixing and delivery time to 60 minutes.
 - 3. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees Fahrenheit. Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.
 - 4. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
 - 5. Fog spray forms, reinforcing steel and subgrade just before concrete is placed.
- D. Thermal Change: Protect all concrete from rapid drying due to wind, overheating due to the direct sun, freezing or thermal shock, to assure consistent curing for all concrete. Covering, reflective covering, shading, heating, insulating, cooling, wetting are measures which should be considered in maintaining minimal moisture loss at a relatively constant temperature during curing.

1.9 JOB CONDITIONS

- A. Design Loads: Do not place, handle or store products, equipment, or other materials on structure, before concrete has reached its design strength and in such a manner as to not exceed design loads. Check with Structural Engineer for design loads of each area and review of construction loading and proposed distribution of construction loads. Any area damaged by construction operation must be repaired or replaced at no cost to the Owner.
- B. Construction Damage: Do not permit walking or wheeling on fresh concrete until it has set for a sufficient length of time. Protect all concrete which will be permanently exposed in finished work from damage from construction operations specifically falling tools, mortar or other objects.
- C. On the framed floors, the steel beams have been designed to deflect under the weight of the wet concrete. The contractor shall provide additional concrete fill as necessary to produce a level floor.

PART 2 - PRODUCTS

2.1 CEMENT

- A. Portland Cement: ASTM C-150, Type I (unless otherwise approved by the Structural Engineer). Use one brand of cement throughout project unless otherwise acceptable to the Architect.
- B. Fly Ash: ASTM C-618, Type C or Type F.
 - 1. 15% - 20% fly ash may be used in concrete poured and cured above 50° Fahrenheit.

C. Blended Hydraulic Cement: ASTM C595, excluding types S and SA.

D. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 120.

1. 25% - 35% granulated slag may be used in concrete poured and cured above 50° Fahrenheit

2.2 FINE AGGREGATE

A. Sand: ASTM C-33. Clean, hard, natural sand, or manufactured sand, or a combination of both.

1. Source: From the same source throughout the work for each type of concrete. Approval subject to color evaluation.

2.3 COARSE AGGREGATE

A. Normal Weight Concrete: ASTM C-33, ACI-211.1, ACI-304-1. Aggregate shall have similar color characteristics of sand and cement.

1. Maximum Size Aggregate: Maximum of 1-1/2" (1/2" for framed concrete slab poured on metal deck joist) but not more than 3/4 of clear distance between forms and the reinforcing bar and 3/4 of minimum clear spacing between reinforcing bars, and as recommended in ACI-211.

B. Grout for Masonry: ASTM C404; maximum size of aggregate shall be 3/8" but not more than 3/4" of the clear distance between the inside block face and the reinforcing bar.

2.4 WATER

A. Clean and free from deleterious amounts of acids, alkalis or organic materials.

2.5 ADMIXTURES

A. Modifiers: To accelerate the hardening of the concrete or to produce higher than normal strength at early periods; will not be permitted unless specifically approved. Do not use any admixture which will affect the concrete color. Do not use admixtures without written approval and strict quality control.

B. Water-Reducing Admixtures: ANSI/ASTM C-494, Type A, and contain not more than 0.05% chloride ions.

1. Manufacturers:
 - a. Euclid Chemical Co. - "Eucon WR-75"
 - b. Master Builders Technologies - "Pozzolith Normal" or "Polyheed"
 - c. Sika Chemical Corp. - "Plastocrete 161"
 - d. Chem-Masters Corp - "Chemtard"
2. Products are subject to compliance to all project requirements.

C. Accelerating Admixtures: ANSI/ASTM C-494, Type C, A non-corrosive, non-chloride set accelerating admixture that accelerates cement hydration resulting in shortened setting times and increased early age strengths, especially in cooler temperatures. Admixture shall not contain not more than 0.05% chloride ions.

1. Manufacturers:
 - a. Master Builders Technologies - "Pozzolith 555"
 - b. Grace Construction Products - "PolarSet"
 2. Products are subject to compliance to all project requirements.
 3. Use accelerating admixture in concrete slabs placed at ambient temperatures below 50 degrees Fahrenheit.
- D. Water-Reducing and Retarding Admixtures: ASTM C-494, Type D.
1. Manufacturers:
 - a. Sika Chemical Corp. - "Plastiment"
 - b. Master Builders Technologies - "Pozzolith R"
 - c. Gifford Hill - PSI 400N/PSI 400R
 2. Locations: Not permitted in footings or foundations. Retarding densifier shall be used as required by climatic conditions at the time of the pour as recommended by the manufacturer.
 3. Manufacturers Assistance: The admixture manufacturer shall be required to have available a qualified representative to assist in the proportioning and to advise on the use of the product for adjustment due to weather or job conditions.
- E. High Range Water-Reducing Admixture (Super Plasticizer): ASTM C-494, Type F or Type G and contain not more than 0.05% chloride ions.
1. Manufacturers:
 - a. W. R. Grace - "WRDA 19" or "Daracem"
 - b. Prokrete Industries, Inc. - "PSP"
 - c. Anti-Hydro - "Super P"
 - d. Sika Chemical Corp. - "Sikament 300"
 - e. ICI Americas Corp. - "Mighty 150"
 - f. Euclid Chemical Co. - "Eucon 37"
 - g. Gifford-Hill - "PSI Super"
 - h. Master Builders Technologies - "Rheobuild"
 2. Products are subject to compliance with all project requirements.
- F. Air Entraining Admixture: ASTM C-260; Air Content 6% +/- 1%.
1. Manufacturers:
 - a. W. R. Grace - "Darex AEA" or "Daravair"
 - b. Sika Chemical Corp. - "Sika-AER"
 - c. Sonneborn/Contech - "Aerolith"
 - d. Master Builders Technologies: - "MB-VR" or "Micro-Air"
 - e. Gifford Hill - "Air-tite"
 2. Locations: Use in all concrete which is exposed to the weather. Air Entraining Admixture shall not be used in slabs with a trowel finish.
- G. Calcium Chloride or admixture containing more than 0.05% chloride ions are not permitted.

2.6 BONDING AGENTS

1. Presoak existing concrete surface to a saturated surface dry condition immediately prior to pouring of adjacent concrete slab sections.

2.7 NON-BONDING AGENTS

- A. Non-bonding agents shall conform to ASTM C-309, Type I and AASHTO M-148, Type I.

- B. Non-bonding agents shall be applied in strict accordance with the manufacturer's recommendations.
- C. Products: "Tilt-Eez" by Conspec Marketing and Manufacturing Company.

2.8 CURING MATERIALS

- A. Curing Compound: Liquid-Type membrane-forming; ASTM C-309, Type I, Class A. Moisture loss not more than 0.055 GR./SQ.CM. when applied at 200 SQ. FT./GAL.
 - 1. Manufacturer:
 - a. "A-H 3 Way Sealer," Anti-Hydro Co., Inc.
 - b. "Conspec #1," Conspec Marketing & Mfg. Co.
 - c. "Euco cure," Euclid Chemical Co.
 - d. "Kure-N-Seal," Sonneborn-Rexnord.
 - e. "Masterkure," Master Builders, Inc.
 - f. or approved equal
 - 2. Note: Certified compatibility with approved surface sealing agents, mastics, adhesives, colored hardeners, finishes and deferred bonding, is required, before compound may be used where subsequent finishes are indicated.
 - 3. Location: All concrete walls, slabs, beams, stairs and columns of the building prior to and immediately after removal of forms.

2.9 SURFACE TREATMENTS

- A. Sealing Compound: Liquid-Type, membrane forming; ASTM C-309, Type I, Class A. Capable of preventing infiltration of water borne chlorides.
 - 1. Manufacturers:
 - a. "Conspec #1" - Conspec Marketing & Mfg. Co.
 - b. "Kure-N-Seal" - Sonneborne - Rexnord
 - c. Or approved equal.
 - In areas of colored concrete, use a sealing compound that is recommended by the manufacturer of the color hardener
 - 2. Locations: All interior concrete floor slabs, stairs and concrete walls left exposed at the completion of the project.

2.10 NON-SHRINK GROUT

- A. CRD C-621 and ASTM C 1107, factory pre-mixed non-metallic grout subject to compliance with requirements. Provide one of the following:
 - 1. "Masterflow 713"; Master Builders
 - 2. "SonogROUT"; Sonneborn-Contech.
 - 3. "Euco-NS"; Euclid Chemical Co.
 - 4. "Five Star Grout"; U. S. Grout Co.
 - 5. "DuragROUT"; L & M Const. Chemical Co.
 - 6. "Supreme"; Gifford Hill

2.11 CONCRETE MIXES

- A. Compressive Strengths: Minimum concrete compressive strengths are as follows:

1. 3000 psi; 28-day compressive strength; 517 lbs. cement per cu.yd. minimum W/C ratio, 0.56 maximum. (All concrete except as otherwise noted.)
 2. 4000 psi: 28 day compressive strength: 564 lbs. cement per cu. yd. minimum W/C ratio, 0.050 maximum (All concrete for framed slabs.)
 3. 4500 psi; 28 day compressive strength; 635 lbs. cement per cu. yd. minimum; W/C ratio, 0.40 maximum. (All exterior concrete, retaining walls, associated footings.)
 4. Modify above water-cement (w/c) ratio as follows for the following conditions:
 - a. Concrete subjected to freezing and thawing: w/c = 0.45 maximum.
- B. Mix Design: Proportion by the procedure described in ACI 318. All concrete; ready-mixed; on site batch plant; mixed and transported in accordance with ASTM C-94, Alternate No. 1 or No. 2 and ACI 304.
1. Responsibility: The Contractor is solely responsible for creating and paying for all concrete design mixes fully workable of required strengths that produce finishes acceptable to the Architect. All mixes shall be purchased from the same supplier throughout the work.
- C. Mixing: After introduction of water to the cement and aggregates, concrete which has been mixed longer than 1-1/2 hours or 300 revolutions, shall not be placed. In no case shall concrete be used that has been mixed so long that the initial set of the concrete shall occur sooner than 15 minutes after placement.
1. Truck mixing: Trucks must be equipped with water gauges and revolution counters. Defer addition of water to latest possible revolution counters. Defer addition of water to latest possible time. When temperatures or other conditions cause a deviation in slump or setting characteristics, provide approved measures to maintain normal conditions.
- D. Slumps: ACI 301, paragraph 4.2.2.2. Proportion and design mixes to result in concrete slump at point of placement as follows:
1. Ramps, slabs, and sloping surfaces: Not more than 3".
 2. Reinforced foundation systems: Not less than 1" and not more than 3".
 3. Concrete containing HRWR admixture (super plasticizer): Not more than 8" after addition of HRWR to verified 2" - 3" slump concrete.
 4. Other Concrete: Not more than 4".
- E. Dry Density:
1. Structural Normal Weight Concrete: 148 lbs./c.f. maximum. (all concrete except as otherwise noted)

2.12 MASONRY GROUT MIX

- A. Compressive Strengths: Minimum 28 day compressive strength shall be 3000 psi; standard weight; 5.5 bags (94 lbs.)/c.f. w/c = 0.60 maximum for all masonry grout.
- B. Mix Design: Proportion per the requirements of ASTM C476-83 - "Standard Specification for Grout for Masonry" ready mixed and transported in accordance with ASTM C-94, alternate No. 1 and ACI 304.
 1. Responsibility: The Contractor is solely responsible for creating and paying for all grout design mixes fully workable, of required strengths that produce finishes acceptable to the architect. All mixes shall be purchased from the same supplier throughout the work.
- C. Mixing: After introduction of water to the cement and aggregates, grout that has been mixed

longer than 1.5 hours should not be placed. Because of its high slump, ready mix grout shall be continuously agitated after mixing until placement. In no case shall grout be used that has been mixed so long that the initial set of the concrete shall occur sooner than 15 minutes after placement.

1. Truck Mixing: Trucks must be equipped with water gauges and revolution counters. Defer addition of water to latest possible revolution counters. Defer addition of water to latest possible time. When temperatures or other conditions cause a deviation in slump or setting characteristics, provide approved measures to maintain normal conditions.
- D. Slump: Water may be introduced at the plant to produce a maximum slump of 6". Additional water may be added at the jobsite immediately prior to placement to produce a maximum slump of 11".

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordination: Check forms, reinforcing steel and supports, expansion and contraction joints, and placement of built-in and embedded items. Verify drawing dimensions with actual field conditions. Inspect related work and adjacent surfaces. Report all conditions which prevent proper execution of this work.
1. Do not place concrete until foregoing related work has been completed and inspected.
- B. Built-in and Embedded Items: Allow sufficient time for the various trades between erecting of forms and placing of concrete, to permit the proper installation of their work. Do not place concrete until embedded items have been coordinated and installed.
1. Coordination: Refer to Formwork, also examine the drawings and specifications for work of other trades, especially for Mechanical and Electrical Work.
 2. Conduits: Do not allow conduits or pipes to be placed in the concrete.
 3. Precautions: Embedding of aluminum inserts or conduit in the concrete will not be permitted.
 4. Anchorage and Supports: Refer to Concrete Accessories and Miscellaneous Metals Sections for items to be embedded in the concrete. Refer to Formwork for installation.
- C. Surface to Receive Concrete: Clean, well thawed, damp surfaces, free from standing water. Before placing concrete, remove all debris, water and ice from the places to be occupied by the concrete. Wood forms shall be thoroughly wetted (except in freezing weather) or oiled and the reinforcement cleaned of ice or other coatings. Do not place concrete on soft mud or dry porous earth (see Spec Section 31 2000).
- D. Screed Levels: Set edge forms or bulkheads and wet intermediate screed strips for slabs to obtain the required elevations and contours in the finished slab surface. Provide and secure units sufficiently strong to support the types of screeds required.
1. Alignment: Align the concrete surface to the elevation of the screed strips by the use of strike-off templates or accepted compacted type screeds.

3.2 CONVEYING AND PLACING

- A. Reference Standard: In accordance with requirements of Building Code Requirements for Reinforced Concrete, ACI 318, Chapter 5, Concrete Quality, Mixing and Placing, Section 5.9, Conveying, and Section 5.10, Depositing, and as modified herein.

- B. Wood Runways: Provide for wheeled equipment for transporting concrete. Do not displace the resteel or vapor barrier.
- C. Conveying: Rapidly handle from mixer to forms and deposit as nearly as possible in its final position to avoid segregation due to rehandling or flowing. Do not permit concrete during passage from mixer to final positioning to come in contact with aluminum surfaces.
- D. Placement: Place concrete of required thickness, compact, level and screed to proper levels to receive finishes specified. Do not deposit partially hardened or retempered concrete. Do not place concrete contaminated by foreign matter.
 - 1. Bearing Walls and Columns: Brace and allow to cure twelve hours before placing concrete superimposed thereon, in accordance with ACI 301, section 5.3.2.4.
 - 2. Slab Reinforcement: Welded wire fabric reinforcing shall be placed at the proper height by installing support steel as specified in specification 03 2000.
 - 3. Slabs: Do not pour faster than can be properly leveled and compacted. Place at point of final repose, directly ahead of the screed bar, vibrating mass just ahead of the screed.

3.3 CONSOLIDATION: ACI 301, Section 5.3.2.5

- A. Compacting: Thoroughly tamp and spade fresh concrete to insure flow into all parts of forms and around reinforcement. Use caution when using vibrators and hand spades to prevent any injury to working face of forms or any movement of the reinforcement.
- B. Concrete shall be placed in such a manner as to insure that alignment of sleeves, embedded plates, and inserts remain unchanged. Special provisions shall be made to insure proper vibration of concrete around bearing plates and inserts.

3.4 LEVELING AND SCREEDING

- A. All top surfaces of poured concrete shall be worked smooth and level. Do not sprinkle dry cement or mixture of cement and sand directly on the surface of the concrete to absorb moisture or to stiffen mix. Surfaces shall be brought to a finish level, free from defects, blemishes, ripples, trowel marks and other irregularities, including footprints and other depressions which may be cause for rejection.
- B. Screeds: Of such type and construction, and so spaced and located as to produce surface tolerances specified.
- C. Unformed Surfaces: Bring to proper levels and slopes, using screeds, and strike-off with a straightedge. Screed twice, the first to strike a full, rough level and move the concrete mass ahead. Follow this with necessary filling of low areas and another screeding to final level. Remove any puddles of "soup," excess water, or laitance. Pull screeds and screed supports and fill all depressions.
 - 1. Floating: Float to a true and uniform surface with no coarse aggregate visible.
- D. Levels and Lines: Establish and check levels and lines by instrument, and from time to time during pours. Finally check lines and levels, again by instrument, after straight edging and screeding. Correct any settlement and/or other irregularities greater than the allowable tolerances.
 - 1. Floor slabs on grade shall be finished to the following requirements:
 - a. The F-numbers which shall apply to the whole floor shall be a flatness $F_f = 30$ or higher, and a levelness $F_l = 25$ or higher.

- b. The minimum local F-numbers which shall apply to the floor area bound by construction and/or control joints shall be a flatness $F_f = 22$ or higher, and a levelness $F_l = 19$ or higher.
 2. The minimum local F-numbers for elevated concrete slab floor areas bound by a structural bay shall be a flatness $F_f = 22$ or higher, and a levelness not to exceed 3/8 inch within any structural bay.
 3. Exterior concrete stairs shall have the treads and landings sloped approximately 1/8" per 12" to assure that no water rests on a riser or the landings.

3.5 UNFORMED CONCRETE SURFACE FINISHES

- A. Reference Standard: All concrete finishes shall be specified designating in ACI 301 Section 5.3.4.2, except as modified herein.
- B. Troweled Finish: After concrete is sufficiently hardened to prevent drawing moisture and fines to the surface, finish trowel until matrix no longer accumulates on the trowel. Do not use cement, sand, or a mixture thereof to absorb excess moisture and do not add water to facilitate troweling. Perform second troweling until there is a distinct ringing sound under the trowel, and smooth, hard furnished surface is obtained. Use liquid curing membrane except where indicated. (See Products)
- C. Interior floor slabs shall have a smooth trowel finish.
- D. Exterior floor slabs shall have a broom or belt finish.

3.6 LIMITATIONS OF OPERATIONS

- A. No construction activity shall be permitted on a concrete deck pour for at least 3 days and until the concrete has achieved at least 75 percent of its specified 28-day compressive strength.

3.7 SURFACING CURING

- A. Application: Apply liquid-type combination curing compound as soon as new concrete is hard enough to support applicator's weight and as soon after final troweling as possible, in such a manner as to prevent marring or damaging troweled surface. Apply in strict accordance with the manufacturer's recommendations, and with the initial application done under the direct supervision of the manufacturer's representative.
- B. During period of dry winds, low humidity, high temperatures, and other conditions causing rapid drying, protect fresh concrete with an evaporation retardant (mono-molecular film) or fine fog spray of water applied immediately after screeding and bull floating. Maintain protection until final finishing and curing compounds are applied.

3.8 SURFACE SEALING

- A. Sealing Compound Application: The sealing and dustproofing application should be applied when all trades are completed and structure is ready for occupancy. Surface must be free of any dust, dirt, and other foreign matter. Use power tools and/or strippers to remove any incompatible sealers or coatings. Cleanse as required. Apply 2 coats, both at full strength to seal and dustproof the concrete. Allow first coat to dry overnight prior to application of second coat.

3.9 FORMED CONCRETE SURFACES

- A. All formed concrete finishes shall be as specified in ACI 301, Section 5.3.3.4, except as modified herein.
- B. Cork Floated Finish where exposed to view, unless otherwise indicated.
- C. As Cast Formed Finish where not exposed to view, patch as required, unless otherwise indicated.

3.10 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas:
 - 1. Repair and patch defective areas with repair mortar such as Tamms Speedcrete – Redline immediately after removal of forms, when acceptable to Architect.
 - 2. Cut out honeycomb, rock pockets, voids over 1/4" in any dimension, and holes left by tie rods and bolts, down to solid concrete but in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water to a saturated-surface-dry condition and install repair mortar in strict accordance with the manufacturer's specifications.
- B. For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- C. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on surface; and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry pack mortar, or precast cement cone plugs secured in place with bonding agent.
- D. Repair concealed formed surfaces, where possible that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.
- E. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having required slope.
- F. Repair finished unformed surfaces that contain defects which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.03" wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.
- G. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.
- H. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to Architect.
- I. Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with

clean, square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete to a saturated-surface-dry condition. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.

- J. Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method. Groove top of cracks and cut-out holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces to a saturated-surface-dry condition. Mix dry-pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry-pack when concrete surface is still saturated. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.
 - K. Perform structural repairs with prior approval of Architect for method and procedure, using specified epoxy adhesive mortar.
 - L. Repair methods not specified above may be used, subject to acceptance of Architect.
- 3.11 NONCONFORMING STRENGTH: If strength of laboratory control cylinders at 7 or 28 days for any portion of the work falls below required strengths, the Structural Engineer has the right to order a change in proportions for the remaining work, and/or may order additional reshoring and moist-curing of the sections in question. In addition, at his discretion, the Structural Engineer has the right to require tests in accordance with ASTM C-42 (cored cylinders) or order load tests on portions of buildings so affected. Perform all test changes as noted above and/or other required corrective measures as directed by the Structural Engineer at no expense to the Owner, regardless of test results. The structural Engineer is the sole interpreter of additional tests and his judgement is final.
- 3.12 RESPONSIBILITY
- A. The Owner shall employ and pay for services of an independent Testing Laboratory, and an Inspection Agency, acceptable to the Structural Engineer to perform the specified tests and inspection. (ACI 301, Section 1.6.1 and 1.6.2).
 - B. Approvals: The design mix and/or acceptance of the test reports do not in any way relieve the Contractor of his responsibility to insure that the strength, slump and quality of the in-place concrete meets the requirements of the Contract Documents.
 - C. Rejection: The Owner's representative will have the right to reject concrete which does not meet strength and other requirements of the Contract Documents.
 - D. Mixing Design: If the strength of any test cylinder or grout sample fails to meet the ultimate compressive strength, the Owner's representative shall have the right to require a change in proportions to ensure adequate strengths in the remainder of the project.
 - E. Additional Testing: Owner's representative shall have the right to require testing of the concrete by coring, loading or other means, or removal of that portion of the construction covered by those tests, all costs of which to be borne by the Contractor.
- 3.13 CONTRACTOR'S DUTIES: Comply with ACI 301, Section 1.6.3 including but not limited to the following:
- A. Batch Plant Samples: If desired by Contractor, or so requested because of known or indicated problems.

- B. Storage: Provide suitable storage facilities at the job site for test cylinders.
- C. Additional Costs: Pay all costs for coring, drilling, additional testing, remedies and corrections of work which does not meet strength and other requirements of the Contract Documents and/or if failure to perform required duties. Comply with ACI 301, Section 1.6.5.
- D. Other Test Cylinders: For other than compressive strength, such as to determine when forms may be stripped, shall be paid for by the Contractor requesting same.

3.16 TESTING AND INSPECTION

- A. Field and laboratory testing of poured in place concrete and masonry grout shall comply with the testing requirements of Section 01 4000, Quality Control. Perform specified tests and testing in accordance with ACI 301, Section 1.6.4 and ACI 311 "Recommended Practice for Concrete Inspection". Testing Agency shall meet the requirements of ASTM E 329:
- B. Slump Tests: Consistency shall be determined at the project site by means of slump test in accordance with C-143. Results of slump test shall appear on the test reports. Slump tests shall be made at the same time as test cylinders are made and when so directed by the Structural Engineer.
- C. Compression Tests: Each test consists of 4 concrete test cylinders or 4 grout samples broken under compression. Two cylinders/samples shall be broken 7 days after making; and two cylinders/samples shall be broken at 28 days. Strength results of all cylinders/samples broken at 7 days shall achieve a minimum of 65% of the ultimate design strength, 28 days - 100%.
 - 1. Concrete Test Cylinders: 6" diameter x 12" (or 4" diameter x 8" if maximum aggregate size is less than 1") made at the point of deposit, molded, transported cured and tested in accordance with ASTM C-31. One set of compressive test cylinders shall be made for each 100 yards poured. Make not less than one set of cylinders for each day's pour and each class of concrete.
 - 2. Masonry Grout Samples: 3-1/2" square x 7" made at the point of deposit, molded, transported cured and tested in accordance with ASTM C1019-84 - "Standard Method of Sampling and Testing Grout". One set of grout cubes shall be made for each 30 yards poured. Make not less than one set of cubes for each day's pour.
- D. Density Test: When required, density test shall be performed in accordance with ASTM C-138.
- E. Air Content: When required, air content test shall be performed per ASTM C-173 (volumetric method for normal weight concrete) or ASTM C-231 (pressure method for normal weight concrete).
- F. Laboratory Test Reports: Submit to the Structural Engineer immediately upon completion of each test. Test reports shall contain the following information:
 - 1. Exact mix, including quantities of admixtures, etc.
 - 2. Date of pour.
 - 3. Exact location of pour in building.
 - 4. Slump (at truck or on deck specified).
 - 5. Percentage of air-entrained.
 - 6. 7-day test results for first two cylinders tested.
 - 7. 28-day test results shall be reported with both 7 and 28 day results indicated on the same

report.

8. Temperature at time of pour.

G. TESTING LABORATORY DUTIES

1. Furnish all materials for making concrete test cylinders.
2. At test intervals, immediately transport concrete test cylinders and masonry grout samples to the Test Laboratory.
3. Provide verbal results of concrete test cylinders when required by the contractor.
4. Perform concrete density test when required by the Structural Engineer.
5. Provide test reports of all laboratory testing in a timely fashion to the Structural Engineer and Contractor.

H. INSPECTION AGENCY DUTIES

1. Comply with inspection requirements of Section 01 4000, Quality Control Services. Inspect concrete operations and completed work for conformance with Contract Documents and as indicated in ACI 301, Section 1.7.
2. Assign qualified personnel to be on site at all times when operations are scheduled. The Contractor shall note that no concrete operations shall be permitted in their absence.
3. Perform slump tests for all concrete, and masonry grout, and air content tests as specified above. Forward results of these tests to Testing Laboratory for incorporation into laboratory test reports.
4. Make concrete test cylinders and masonry grout cubes in molds provided by Testing Laboratory.
5. Site inspection of poured in placed concrete shall include, but is not limited to the following:
 - a. Insure all concrete and masonry reinforcement is properly inspected per specifications 03 2000 and Division 4 – Masonry
 - b. Masonry grouting operation.
 - c. Slab curing procedures.
 - d. Application of concrete hardener and sealer.
6. Submit daily reports outlining conformance and exceptions of concrete operation to contract documents.
7. Final Report and Certification: The Inspection Agency shall prepare a written report that summarizes the work inspected during the course of the project. A discussion of all deviations from the contract documents and specifications, with their related impact on the final construction, shall be described in detail. The engineer of record shall review this final report, and recommend corrective measures (as deemed necessary) that must be made prior to final acceptance of the work. Prior to final payment, a written report certifying that the work meets the requirements of the contract documents, specifications, and all governing agencies shall be prepared, submitted, and approved by the Architect.

END OF SECTION

SECTION 03 3500

UNDER-SLAB VAPOR BARRIER

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. Products supplied under this section:
 - 1. Vapor barrier and installation accessories for installation under concrete slabs.
- B. Related Requirements:
 - 1. Section 07 2100 "Thermal Insulation" for vapor retarders integral with insulation products.

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM E1745- 11Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
 - 2. ASTM E1643- 11Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
- B. Technical Reference - American Concrete Institute (ACI):
 - 1. ACI 302.2R-06 Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Quality control/assurance:
 - 1. Summary of test results per paragraph 9.3 of ASTM E 1745.
 - 2. Manufacturer's samples and literature.
 - 3. Manufacturer's installation instructions for placement, seaming and penetration repair instructions.
 - 4. All mandatory ASTM E1745 testing must be performed on a single production roll per ASTM E1745 Section 8.1.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Vapor barrier shall have all of the following qualities:

1. Maintain permeance of less than 0.01 Perms [grains/(ft² · hr · inHg)] as tested in accordance with mandatory conditioning tests per ASTM E1745 Section 7.1 (7.1.1-7.1.5).
2. Other performance criteria:
 - a. Strength: ASTM E1745 Class A.
 - b. Thickness: 15 mils minimum

B. Vapor barrier products:

1. Stego Wrap Vapor Barrier (15-mil) by Stego Industries LLC., (877) 464-7834
www.stegoindustries.com.
2. Griffolyn G15 by Reef Industries, Inc
3. Vaporflex 15 by Layfield

2.2 ACCESSORIES

- A. Seams: provide seaming tape suitable to manufacturer.
- B. Penetrations of Vapor barrier: Provide mastic and tape suitable to manufacturer.
- C. Perimeter/edge seal: provide termination bars, clamps and double-sided tape suitable to manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ensure that subsoil is approved by Architect or Geotechnical Engineer.
 1. Level and compact base material.

3.2 INSTALLATION

- A. Install vapor barrier in accordance ASTM E 1643.
 1. Unroll vapor barrier with the longest dimension parallel with the direction of the concrete placement and face laps away from the expected direction of the placement whenever possible.
 2. Extend vapor barrier over footings and grade beams to a distance acceptable to the structural engineer or stop at impediments such as dowels and waterstops.
 3. Seal vapor barrier to slab perimeter/edge or footing/grade beam with double sided tape, termination bar, or both. remove dirt, debris, and mud prior to concrete placement.
 4. Overlap joints 6 inches and seal with manufacturer's tape.
 5. Seal all penetrations (including pipes) per manufacturer's instructions.
 6. No penetration of the vapor barrier is allowed except for reinforcing steel and permanent utilities.
 7. Repair damaged areas by cutting patches of vapor barrier, overlapping damaged area 6 inches and taping all sides with tape.
- B. Sheet Vapor Barriers: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
 1. Following leveling and tamping of granular base for slabs on grade, place vapor barrier sheeting with longest dimension parallel with direction of pour and face laps away from the expected direction of the placement whenever possible.
 2. Extend vapor barrier to the perimeter of the slab. If practicable, terminate it at the top of the slab, otherwise (a) at a point acceptable to the structural engineer or (b) where obstructed by impediments, such as dowels, waterstops, or any other site condition

requiring early termination of the vapor barrier. At the point of termination, seal vapor barrier to the foundation wall, grade beam or slab itself.

3. Lap joints 6 inches and seal with manufacturer's recommended tape.
4. Apply seam tape to a clean and dry vapor barrier.
5. Seal all penetrations (including pipes) per manufacturer's instructions.
6. Avoid the use of non-permanent stakes driven through vapor retarder.
7. If non-permanent stakes are driven through vapor retarder, repair as recommended by vapor retarder manufacturer.
8. Repair damaged areas with vapor barrier material of similar (or better) permeance, puncture and tensile.

END OF SECTION

SECTION 04 2000

UNIT MASONRY

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. Concrete masonry units.
2. Concrete building brick.
3. Mortar and grout.
4. Steel reinforcing bars.
5. Masonry joint reinforcement.
6. Ties and anchors.
7. Embedded flashing.
8. Miscellaneous masonry accessories.
9. Masonry-cell insulation.

B. Products Installed but not Furnished under This Section:

1. Steel lintels in unit masonry.
2. Steel shelf angles for supporting unit masonry.
3. Cavity wall insulation.

C. Related Sections:

1. Section 033000 "Cast-in-Place Concrete" for installing dovetail slots for masonry anchors.
2. Section 04 4200 "Exterior Stone Cladding" for stone trim secured with stone anchors.
3. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
4. Section 055000 "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.
5. Section 07 2100 "Thermal Insulation" for cavity wall insulation.
6. Section 076200 "Sheet Metal Flashing and Trim" for sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
7. Section 321400 "Unit Paving" for exterior unit masonry paving.

1.3 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."
 - 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Initial Selection:
 - 1. Colored mortar.
 - 2. Weep holes/cavity vents.
- D. Samples for Verification: For each type and color of the following:
 - 1. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project.
 - 2. Weep holes and cavity vents.
 - 3. Accessories embedded in masonry.

1.6 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. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
- B. Qualification Data: For testing agency.
- C. Material Certificates: For each type and size of the following:
 - 1. Masonry units.
 - a. Include data on material properties and material test reports substantiating compliance with requirements.
 - 2. Cementitious materials. Include brand, type, and name of manufacturer.
 - 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.
- D. 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 according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

E. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for each type of exposed unit masonry construction in sizes approximately **48 inches (1200 mm)** long by **36 inches (900 mm)** high by full thickness.
2. Build sample panels facing south.
3. Where masonry is to match existing, erect panels adjacent and parallel to existing surface.
4. Clean one-half of exposed faces of panels with masonry cleaner indicated.
5. Protect approved sample panels from the elements with weather-resistant membrane.
6. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
 - a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Architect in writing.

C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Provide Mock-up Panel as indicated on drawings.
2. Panels to include all components necessary for a complete project, including finished masonry and all back-up materials and ties, damproofing, waterproofing, insulation, air barriers, flashing, joint sealants,
 - a. Include other materials as indicated on drawings.
 - b. Include a sealant-filled joint at least **16 inches (400 mm)** long in exterior wall mockup.
 - c. Include through-wall flashing installed for a **24-inch (600-mm)** length in corner of exterior wall mockup approximately **16 inches (400 mm)** down from top of mockup, with a **12-inch (300-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.
3. List of Materials Used in Constructing Mockups: Listing generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to
4. Locate panels in the locations indicated or, if not indicated, as directed by Architect.
5. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
6. Protect accepted mockups from the elements with weather-resistant membrane.

7. Maintain panels during construction in an undisturbed condition as a standard for judging the completed Work.
8. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
9. Demolish and remove panels when directed.

1.8 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 designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and 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.

1.9 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.
 2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of **24 inches (600 mm)** down face next to unconstructed wythe and hold cover 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 ACI 530.1/ASCE 6/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.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

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 structural unit masonry that develops indicated net-area compressive strengths at 28 days.
 1. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

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 in the standard. Do not use units where such defects will be 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 shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.4 CONCRETE MASONRY UNITS

- A. 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 square-edged units for outside corners unless otherwise indicated.
- B. CMUs: ASTM C 90.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of **2150 psi (14.8 MPa)**.
 - 2. Density Classification: Normal weight unless otherwise indicated.
 - 3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

2.5 CONCRETE AND MASONRY LINTELS

- A. General: Provide one of the following:
- B. Concrete Lintels: ASTM C 1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength not less than CMUs.
- C. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 033000 "Cast-in-Place Concrete," and with reinforcing bars indicated.
- D. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs 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: Aggregate for mortar and grout, cement, and lime shall be extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.
- B. Portland Cement: ASTM C 150, 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.
- C. Hydrated Lime: ASTM C 207, Type S.
- D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- E. Masonry Cement: ASTM C 91.
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Essroc, Italcementi Group](#);
 - b. [Lehigh Cement Company](#);
- F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.

1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Davis Colors](#); True Tone Mortar Colors.
 - b. [Solomon Colors, Inc.](#); SGS Mortar Colors.

 - G. Colored Cement Product: Packaged blend made from portland cement and hydrated lime or mortar cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.
 1. Colored Portland Cement-Lime Mix:
 - a. **Products:** Subject to compliance with requirements, provide one of the following:
 - 1) [Capital Materials Corporation](#); Riverton Portland Cement Lime Custom Color.
 - 2) [Holcim \(US\) Inc.](#); Rainbow Mortamix Custom Color Cement/Lime.
 - 3) [Lafarge North America Inc.](#); Eaglebond Portland & Lime.
 - 4) [Lehigh Cement Company](#); Lehigh Custom Color Portland/Lime Cement.
 2. Colored Masonry Cement:
 - a. **Products:** Subject to compliance with requirements, provide one of the following:
 - 1) [Essroc, Italcementi Group](#); Brixment-in-Color.
 - 2) [Holcim \(US\) Inc.](#); Rainbow Mortamix Custom Color Masonry Cement.
 - 3) [Lafarge North America Inc.](#); U.S. Cement Custom Color Masonry Cement.
 - 4) [Lehigh Cement Company](#); Lehigh Custom Color Masonry Cement.
 3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
 4. Pigments shall not exceed 10 percent of portland cement by weight.
 5. Pigments shall not exceed 5 percent of mortar cement by weight.

 - H. Aggregate for Mortar: ASTM C 144.
 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.

 - I. Aggregate for Grout: ASTM C 404.

 - J. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Euclid Chemical Company \(The\)](#); Accelguard 80.
 - b. [Grace Construction Products, W. R. Grace & Co. - Conn.](#); Morset.
 - c. [Sonneborn Products, BASF Aktiengesellschaft](#); Trimix-NCA.

 - K. Water: Potable.
- 2.7 REINFORCEMENT
- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, **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: ASTM A 951/A 951M.
1. Interior Walls: Hot-dip galvanized, carbon steel.
 2. Exterior Walls: Hot-dip galvanized, carbon steel.
 3. Wire Size for Side Rods: 0.148-inch (3.77-mm) diameter.
 4. Wire Size for Cross Rods: 0.187-inch (4.76-mm) diameter.
 5. Wire Size for Veneer Ties: 0.187-inch (4.76-mm) diameter.
 6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
 7. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.
- D. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder or truss type with single pair of side rods.
- E. Masonry-Joint Reinforcement for Multiwythe Masonry:
1. Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches (100 mm) wide, plus 2 side rods at each wythe of masonry 4 inches (100 mm) wide or less.
 2. Tab type, either ladder or truss design, with 1 side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face.
 3. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches (32 mm). Size ties to extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.

2.8 TIES AND ANCHORS

- A. General: Ties and anchors shall 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 A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
 2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304.
 3. Stainless-Steel Sheet: ASTM A 666, Type 304.
 4. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
 5. Stainless-Steel Bars: ASTM A 276 or ASTM a 666, Type 304.
- C. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches (50 mm) parallel to face of veneer.
- D. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches (100 mm) wide.
1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches (50 mm) long may be used for masonry constructed from solid units.
 2. Where wythes do not align and are of different materials, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches (32 mm).

3. Wire: Fabricate from **3/16-inch- (4.76-mm-)** diameter, stainless-steel wire.
- E. 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, stainless-steel wire.
 2. Tie Section: Triangular-shaped wire tie, sized to extend within **1 inch (25 mm)** of masonry face, made from **0.25-inch- (6.35-mm-)** diameter, stainless-steel wire.
- F. 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.
 1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from **0.109-inch- (2.78-mm-)** thick, stainless-steel sheet.
 2. Tie Section: Triangular-shaped wire tie, sized to extend within **1 inch (25 mm)** of masonry face, made from **0.187-inch- (4.76-mm-)** diameter, stainless-steel wire.
- G. Partition Top anchors: **0.105-inch- (2.66-mm-)** thick metal plate with **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.
- H. 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 bent to configuration indicated.
 1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.
- I. Adjustable Masonry-Veneer Anchors:
 1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
 - a. Structural Performance Characteristics: Capable of withstanding a **100-lbf (445-N)** load in both tension and compression without deforming or developing play in excess of **0.05 inch (1.3 mm)**.
 2. Fabricate sheet metal anchor sections and other sheet metal parts from **0.109-inch- (2.78-mm-)** thick stainless-steel sheet.
 3. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from **0.187-inch- (4.76-mm-)** diameter, stainless-steel wire unless otherwise indicated.
 4. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.
 - a. **Products:** Subject to compliance with requirements, provide one of the following:
 - 1) **Heckmann Building Products Inc.;** Pos-I-Tie.
 - 2) **Wire-Bond;** SureTie.
 - b. Anchor Section: Corrosion-resistant, self-drilling, eye-screw designed to receive wire tie. Eye-screw has spacer that seats directly against framing and is same thickness as sheathing and has gasketed, washer head that covers hole in sheathing.
 5. Stainless-Steel Drill Screws for Steel Studs: Proprietary fastener consisting of carbon-steel drill point and 300 Series stainless-steel shank, complying with ASTM C 954 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.

2.9 MISCELLANEOUS ANCHORS

- A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.
- B. Dovetail Slots in Concrete: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from **0.034-inch (0.86-mm)**, galvanized steel sheet.
- C. Anchor Bolts: Headed or L-shaped steel bolts complying with **ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6)**; with **ASTM A 563 (ASTM A 563M)** hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.10 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual", Section 076200 "Sheet Metal Flashing and Trim" and as follows:
 - 1. Stainless Steel: ASTM A 240/A 240M, Type 304, **0.016 inch (0.40 mm)** thick.
 - 2. Fabricate continuous flashings in sections **96 inches (2400 mm)** long minimum, but not exceeding **12 feet (3.7 m)**. Provide splice plates at joints of formed, smooth metal flashing.
 - 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 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 mm)** to form a stop for retaining sealant backer rod.
 - 6. Metal Expansion-Joint Strips: Fabricate from stainless steel to shapes indicated.
 - 7. Provide Stainless Steel end dams at all Flashing terminations.
- B. Flexible Flashing: Use the following where indicated:
 - 1. Copper-Laminated Flashing: **7-oz./sq. ft. (2-kg/sq. m)** copper sheet bonded between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
 - a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1) [Advanced Building Products Inc.](#)
 - 2) [Hohmann & Barnard, Inc.](#)
 - 3) [Wire-Bond.](#)
 - 4) [York Manufacturing, Inc.](#)
- C. 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 sealant stop or flexible flashing with a metal drip edge.
 - 4. Where flashing is fully concealed, use metal flashing or flexible flashing..
- D. Solder and Sealants for Sheet Metal Flashings: As specified in Section 07 6200 "Sheet Metal Flashing and Trim."
 - 1. Solder for Stainless Steel: ASTM B 32, Grade Sn96, with acid flux of type recommended by stainless-steel sheet manufacturer.

2. Elastomeric Sealant: ASTM C 920, chemically curing urethane polysulfide or silicone 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: Stainless-steel sheet **0.019 inch** by **1-1/2 inches** (**0.48 mm** by **38 mm**) with a **3/8 inch** (**10-mm**) sealant flange at top.

2.11 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or urethane.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 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, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Weep/Vent Products: Use one of the following unless otherwise indicated:
 1. Wicking Material: Absorbent rope, made from cotton or UV-resistant synthetic fiber], **1/4 to 3/8 inch** (**6 to 10 mm**) in diameter, in length required to produce **2-inch** (**50-mm**) exposure on exterior and **18 inches** (**450 mm**) in cavity. Use only for weeps.
 2. Round Plastic Weep/Vent Tubing: Medium-density polyethylene, **3/8-inch** (**9-mm**) OD by **4 inches** (**100 mm**) long.
 3. 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 mm**) less than depth of outer wythe, in color selected from manufacturer's standard.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) [Advanced Building Products Inc.](#)
 - 2) [Heckmann Building Products, Inc.](#)
 - 3) [Hohmann & Barnard, Inc.](#)
 - 4) [Wire-Bond.](#)
- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - b. [Advanced Building Products Inc.](#)
 - c. [CavClear/Archovations, Inc.](#)
 - d. [Heckmann Building Products, Inc.](#)
 - e. [Hohmann & Barnard, Inc.](#)
 - f. [Mortar Net Solutions.](#)
 - g. [Wire-Bond.](#)
 2. Provide one of the following configurations:
 - a. Strips, full-depth of cavity and **10 inches** (**250 mm**) high, with dovetail shaped notches **7 inches** (**175 mm**) deep that prevent clogging with mortar droppings.

- b. Sheets or strips full depth of cavity and installed to full height of cavity.
- F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and 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.
- 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Dayton Superior Corporation, Dur-O-Wal Division](#); D/A 810, D/A 812 or D/A 817.
 - b. [Heckmann Building Products Inc.](#); No. 376 Rebar Positioner.
 - c. [Hohmann & Barnard, Inc.](#); #RB or #RB-Twin Rebar Positioner.
 - d. [Wire-Bond](#); O-Ring or Double O-Ring Rebar Positioner.

2.12 MASONRY CLEANERS

- A. Job-Mixed Detergent Solution: Solution of ½-cup (0.14-L) dry measure tetrasodium polyphosphate and ½-cup (0.14-L) dry measure laundry detergent dissolved in 1 gal. (4-L) of water.

2.13 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 or mortar cement 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 C 270, 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 S or Type N.
 - 4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
- D. Pigmented Mortar: Use colored cement product.
- 1. Pigments shall not exceed 10 percent of portland cement by weight.
 - 2. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
 - 3. Mix to match Architect's sample.
 - 4. Application: Use pigmented mortar for exposed mortar joints with the following units:
 - a. Exterior stone cladding.
- E. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa).
3. Provide grout with a slump of 8 to 11 inches (203 to 279 mm) as measured according to ASTM C 143/C 143M.

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 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 impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- D. 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.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
 1. Mix units from several pallets or cubes as they are placed.

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)** 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 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)**. Do not vary from adjacent bed-joint and head-joint thicknesses by more than **1/8 inch (3 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 (1.5 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 (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 racking 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 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 non-load-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 non-load-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 07 8443 "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.
 - 5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.
- B. Lay solid 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.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.
- E. Cut joints flush where indicated to receive waterproofing cavity wall insulation and air barriers unless otherwise indicated.

3.6 COMPOSITE MASONRY

- A. Use continuous horizontal-joint reinforcement installed in horizontal mortar joints for bond tie between wythes.
- B. Bond wythes of composite masonry together using bonding system indicated on Drawings.
- C. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.
- D. Corners: Provide interlocking masonry unit bond in each wythe and course at corners unless otherwise indicated.
 - 1. Provide continuity with masonry joint reinforcement at corners by using prefabricated L-shaped units as well as masonry bonding.
- E. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:
 - 1. Provide individual metal ties not more than **16 inches (406 mm)** o.c.
 - 2. Provide continuity with masonry joint reinforcement by using prefabricated T-shaped units.
 - 3. Provide rigid metal anchors not more than **48 inches (1220 mm)** o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

3.7 CAVITY WALLS

- A. Bond wythes of cavity walls together using one of the following methods:
 - 1. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
 - b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.
 - c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
 - 2. Header Bonding: Provide masonry unit headers extending not less than **3 inches (76 mm)** into each wythe. Space headers not over **8 inches (203 mm)** clear horizontally and **16 inches (406 mm)** clear vertically.
 - 3. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.
- B. Bond wythes of cavity walls together using bonding system indicated on Drawings.
- C. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
- D. Apply air barrier to face of backup wythe to comply with Section 072726 "Fluid-Applied Membrane Air Barriers."
- E. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately **12 inches (300 mm)** o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining

obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.8 ANCHORING 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 and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 2. Insert slip-in anchors in metal studs as sheathing is installed. Provide one anchor at each stud in each horizontal joint between sheathing boards.
 3. Embed connector sections and continuous wire in masonry joints. Provide not less than **2 inches (50 mm)** of air space between back of masonry veneer and face of sheathing.
 4. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 5. Space anchors as indicated, but not more than **16 inches (406 mm)** o.c. vertically and **24 inches (610 mm)** o.c. horizontally with not less than 1 anchor for each **2.67 sq. ft. (0.25 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.
- B. Provide not less than **2 inches (50 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.

3.9 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.

3.10 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 inch (25 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.

3.11 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.
- C. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than **3/8 inch (10 mm)**.
1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.
- D. Locations:
1. As indicated, or if not indicated, provide vertical control joints spaced at maximum of 30'-0" on center and at points of natural weakness in masonry work.
 2. Above and below major openings in wall
 3. At vertical chase, recesses and other points of reduction in wall thickness.
 4. Where end of masonry wall butts against supporting structure.
 5. Where masonry partitions are installed across control joints in floor slabs, make nearest vertical wall joint on one side of floor control joint, a wall control joint.

3.12 LINTELS

- A. Install steel lintels where indicated.
- B. Provide concrete or 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.
- C. Provide minimum bearing of **8 inches (200 mm)** at each jamb unless otherwise indicated.

3.13 FLASHING, WEEP HOLES, CAVITY DRAINAGE, 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. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, 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. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of **8 inches (200 mm)**, and **1-1/2 inches (38 mm)** into the inner wythe. Form **1/4-inch (6-mm)** hook in edge of flashing embedded in inner wythe.
 3. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least **8 inches (200 mm)**; with upper edge tucked under building paper or building wrap, lapping at least **4 inches (100 mm)**. Fasten upper edge of flexible flashing to sheathing through termination bar.
 4. At lintels and shelf angles, 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.
 5. 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.
 6. Interlock lap joints of sheet metal flashing by overlapping **6 inches (150 mm)** or as recommend by flashing manufacturer, and seal lap with 3 rows of elastomeric sealant, complying with requirements of Division 7 Section "Joint Sealants" for application indicated.
 7. 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.
 8. Make flashing flush to bottom of masonry and provide continuous pan for flow of water through weeps to outside of face of masonry.
 9. End Dams:
 - a. Proved end dams at ends of horizontal flashing that are not continuous.
 - b. Extend flashings beyond opening at least 4 inches and turn up into head joint at least one brick course high, to form pan to direct moisture to outside surface of wall.
 - c. Seal corners of end dams to make watertight.
 10. 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.
 11. Extend sheet metal flashing $\frac{1}{2}$ inch (13mm) beyond face of masonry at exterior and turn flashing down to form a drip.
- C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
1. Use specified weep/vent products or open head joints to form weep holes.

2. Use wicking material to form weep holes above flashing under sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
 3. Space weep holes **24 inches (600 mm)** o.c. unless otherwise indicated.
 4. Space weep holes formed from plastic tubing or wicking material **16 inches (400 mm)** o.c.
 5. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
 6. Trim wicking material flush with outside face of wall after mortar has set.
- E. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than **2 inches (50 mm)**, to maintain drainage.
- F. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.
- G. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products or open head joints to form vents.
1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.14 REINFORCED UNIT MASONRY INSTALLATION

- 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 ACI 530.1/ASCE 6/TMS 602.
- 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 ACI 530.1/ASCE 6/TMS 602 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)**.

3.15 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 shall be done at Contractor's expense.
- B. Inspections: Special inspections according to Level B 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. Prism Test: For each type of construction provided, according to ASTM C 1314 at 7 days and at 28 days.

3.16 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. Clean stone trim to comply with stone supplier's written instructions.

3.17 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. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches (100 mm) in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
3. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.

C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION

SECTION 04 4313

ANCHORED STONE MASONRY VENEER

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. Stone masonry anchored to unit masonry backup.
 - 2. Stone masonry anchored to cold-formed metal framing and sheathing.
- B. Related Requirements:
 - 1. Section 03 3000 "Cast-in-Place Concrete" for installing dovetail slots in concrete for anchoring stone.
 - 2. Section 04 2200 "Unit Masonry" for concealed flashing and veneer anchors.
 - 3. Section 05 5000 "Metal Fabrications" for furnishing steel lintels and shelf angles for stone masonry.
 - 4. Section 07 2100 "Thermal Insulation" for exterior wall insulation
 - 5. Section 07 6200 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each variety of stone, stone accessory, and manufactured product.
- B. Sustainable Design Submittals:
 - 1. Regional Materials: Stone shall be fabricated within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered within 500 miles (800 km) of Project site.
- C. Samples for Initial Selection: For colored mortar and other items involving color selection.
- D. Samples for Verification:
 - 1. For each stone type indicated. Include at least five Samples in each set to match project design intent in range of color, grain, and other visual characteristics in completed Work.
 - 2. For each color of mortar required.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

- B. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, supply sources, and other information as required to identify materials used. Include mix proportions for mortar and source of aggregates.
 - 1. Neither receipt of list nor approval of mockups constitutes approval of deviations from the Contract Documents contained in mockups unless Architect approves such deviations in writing.
- C. Material Test Reports:
 - 1. Stone Test Reports: For stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous three years.
 - 2. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer indicating that sealants will not stain or damage stone. Include interpretation of test results and recommendations for primers and substrate preparation needed for adhesion.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs experienced stonemasons and stone fitters.
- B. Integrated Exterior Mockup: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
 - 1. Build mockups for typical exterior wall in sizes approximately 96 inches (2400 mm) long by 72 inches (1800 mm) high by full thickness, including face and backup wythes and accessories.
 - a. Include stone coping at top of mockup.
 - b. Include a sealant-filled joint at least 16 inches (400 mm) long in mockup.
 - c. Include through-wall flashing installed for a 24-inch (600-mm) length in corner of mockup approximately 16 inches (400 mm) down from top of mockup, with a 12-inch (300-mm) length of flashing left exposed to view (omit stone masonry above half of flashing).
 - d. Include metal studs, sheathing, veneer anchors, flashing, and weep holes in exterior masonry-veneer wall mockup.
 - 2. Protect accepted mockups from the elements with weather-resistant membrane.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Remove mockup at end of construction period unless otherwise arranged by Owner. Mock-up will not be incorporated into completed building. Components to be reused shall be package and turn over to Owner before disassembly

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Sealant Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for compatibility and adhesion testing according to sealant manufacturer's standard testing methods and Section 079200 "Joint Sealants," Samples of materials that will contact or affect joint sealants.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

- B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- C. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, in a dry location, or in covered weatherproof dispensing silos.
- D. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

- A. Protection of Stone Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed stone masonry when construction is not in progress.
 - 1. Extend cover a minimum of **24 inches (600 mm)** down both sides and hold cover securely in place.
- B. Stain Prevention: Immediately remove mortar and soil to prevent them from staining stone masonry face.
 - 1. Protect base of walls from rain-splashed mud and mortar splatter using coverings spread on the ground and over the 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 end of each day to prevent rain from splashing mortar and dirt on completed stone 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 stone masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/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 masonry has dried, but not less than seven days after completing cleaning.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1.10 COORDINATION

- A. Advise installers of other work about specific requirements for placement of reinforcement, veneer anchors, flashing, and similar items to be built into stone masonry.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Stone: Obtain stone from single quarry with resources to provide materials of consistent quality in appearance and physical properties.

- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of uniform quality for each cementitious component from single manufacturer and each aggregate from single source or producer.
- C. Varieties and Sources: Subject to compliance with requirements, provide stone of varieties and from sources Matching Approved Submission for Installation on Building A

2.2 BLUESTONE

- A. Material Standard: ASTM C 616 Type II Quartzite Sandstone containing no Sphalerite
- B. Description: Dark Bluish/Gray
- C. Regional Materials: Bluestone shall be fabricated within 500 miles (800 km) of Project site from stone that has been extracted within 500 miles (800 km) of Project site.
- A. Varieties and Sources: Pennsylvania Bluestone containing no Sphalerite
- B. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
- C. Finish: As indicated for each installation
- D. Thickness: Not less than 4 inches, unless otherwise indicated.

2.3 BUILDING STONE

- A. Regional Materials: Stone shall be fabricated within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered within 500 miles (800 km) of Project site.
- B. Varieties and Sources: Subject to compliance with requirements, provide the following:
 - 1. Butler Quarries, MD: Building "Butler Stone"
- C. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.4 MORTAR MATERIALS

- A. Regional Materials: Aggregate for mortar and grout, cement, and lime shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.
- B. Portland Cement: ASTM C 150, Type I or Type II, except Type III may be used for cold-weather construction; natural color or white cement may be used as required to produce mortar color indicated.
 - 1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.
- C. Hydrated Lime: ASTM C 207, Type S.

- D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Amerimix](#): AMX400, Concord Ivory (Basis of Design)
 - b. [Essroc](#); Saylor's Plus.
 - c. [Holcim \(US\) Inc](#); Rainbow Mortamix Custom Color Cement/Lime.
 - d. [Lafarge North America Inc.](#); Eaglebond.
 - e. [Lehigh Hanson; HeidelbergCement Group](#); Lehigh Custom Color Portland/Lime Cement.
 - f. [Mutual Materials Co.](#); DesignMix Mortar Mix.
- E. Mortar Cement: ASTM C 1329.
- F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in stone masonry mortar.
- G. Aggregate: ASTM C 144 and as follows:
1. For pointing mortar, use aggregate graded with 100 percent passing **No. 16 (1.18-mm)** sieve.
 2. White Aggregates: Natural white sand or ground white stone.
 3. Colored Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.
 - a. Match Architect's sample.
- H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Euclid Chemical Company \(The\); an RPM company](#); Accelguard 80.
 - b. [Grace Construction Products; W.R. Grace & Co. -- Conn.](#); Morset.
 - c. [Sonneborn](#); Trimix-NCA.
- I. Water: Potable.

2.5 STONE TRIM ANCHORS

- A. Stone Trim Anchors: Units fabricated with tabs or dowels designed to engage kerfs or holes in stone trim units and holes for fasteners or postinstalled anchor bolts for fastening to substrates or framing as indicated.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Heckmann Building Products, Inc.](#)
 - b. [Hohmann & Barnard, Inc.](#)
 - c. [Meadow Burke](#).
- B. Materials: Fabricate anchors from stainless steel, ASTM A 240/A 240M or ASTM A 666, Type 304. Fabricate dowels from stainless steel, ASTM A 276, Type 304.
- C. Fasteners for Stone Trim Anchors: Annealed stainless-steel bolts, nuts, and washers; **ASTM F 593 (ASTM F 738M)** for bolts and **ASTM F 594 (ASTM F 836M)** for nuts, **Alloy Group 1 (A1)**.

2.6 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual, Section 04 2200 "Concrete Unit Masonry", and Section 07 6200 "Sheet Metal Flashing and Trim" and as follows:
1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch (0.4 mm) thick.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

- A. Weep/Vent Products: Use the following unless otherwise indicated:
1. Wicking Material: Absorbent rope, made from cotton or UV-resistant synthetic fiber, 1/4 to 3/8 inch (6 to 10 mm) in diameter, in length required to produce 2-inch (50-mm) exposure on exterior and 18 inches (450 mm) in cavity. Use only for weeps.
- B. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Advanced Building Products Inc.; Mortar Break.
 - b. CavClear/Archovations, Inc.; CavClear Masonry Mat.
 - c. Mortar Net Solutions; Mortar Net.
 2. Provide one of the following configurations:
 - a. Strips, full depth of cavity and 10 inches (250 mm) wide, with dovetail-shaped notches 7 inches (175 mm) deep that prevent mesh from being clogged with mortar droppings.
 - b. Strips, not less than 3/4 inch (19 mm) thick and 10 inches (250 mm) wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
- C. Cavity Drainage Mat: 3/8-inch- thick, reticulated, nonabsorbent mesh, made from polyethylene strands and shaped to maintain drainage at weep holes without being clogged by mortar droppings and filter fabric cloth.
1. Products: Subject to compliance with requirements, provide:
 - a. Enkadrain - Akzo Nobel Geosynthetics Company.
 - b. AmerDrain 500 Sheet Drain - American Wick Drain Corporation.

2.8 FABRICATION

- A. General: Fabricate stone units in sizes and shapes required to comply with requirements indicated.
- B. Cut, Split, or Select stone to produce pieces of thickness, size, and shape indicated, including details on Drawings and pattern specified in "Setting Stone Masonry" Article.
- C. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated. Shape beds to fit supports.
- D. Cut and drill sinkages and holes in stone for anchors and supports.
- E. Carefully inspect stone at quarry or fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.
1. Clean sawed backs of stone to remove rust stains and iron particles.

- F. Thickness of Stone: Provide thickness indicated, but not less than the following:
 - 1. Thickness: 4 inches (100 mm) plus or minus 1/2 inch (13 mm). Thickness does not include projection of pitched faces.
- G. Finish exposed stone faces and edges to comply with requirements indicated for finish and to match approved samples and mockups.
 - 1. Finish: Smooth.
 - 2. Finish for Sills: Sand rubbed.
 - 3. Finish for Lintels: Sand rubbed.
 - 4. Finish for Copings: Sand rubbed.
 - a. Finish exposed ends of copings same as front and back faces.

2.9 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.
 - 2. Use portland cement-lime or mortar cement 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.
 - 4. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches required consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in the 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 Stone Masonry: Comply with ASTM C 270, Proportion Specification, and per stone installer recommendations for stone type.
 - 1. Mortar for Setting Stone: Type S or Type N.
 - 2. Match Building A approved type
 - 3. Mortar for Pointing Stone: Type N.
- D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
 - 1. Pigments shall not exceed 10 percent of portland cement by weight.
 - 2. Pigments shall not exceed 5 percent of mortar cement by weight.
 - 3. Match Building A approved product and color selection

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces indicated to receive stone masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone masonry.

- B. Examine substrate to verify that dovetail slots, inserts, reinforcement, veneer anchors, flashing, and other items installed in substrates and required for or extending into stone masonry are correctly installed.
- C. Examine wall framing, sheathing, and weather-resistant sheathing paper to verify that stud locations are suitable for spacing of veneer anchors and that installation will result in a weatherproof covering.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Accurately mark stud centerlines on face of weather-resistant sheathing paper before beginning stone installation.
- B. Coat concrete and unit masonry backup with asphalt dampproofing.
- C. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 SETTING STONE MASONRY

- A. Perform necessary field cutting and trimming as stone is set.
 - 1. Use power saws to cut stone that is fabricated with saw-cut surfaces. Cut lines straight and true, with edges eased slightly to prevent snipping.
 - 2. Use hammer and chisel to split stone that is fabricated with split surfaces. Make edges straight and true, matching similar surfaces that were shop or quarry fabricated.
 - 3. Pitch face at field-split edges as needed to match stones that are not field split.
- B. Sort stone before it is placed in wall to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.
- C. Arrange stones in pattern indicated, matching approved mockup, with course heights and widths as indicated, and uniform joint widths, and with offset between vertical joints as indicated.
- D. Arrange stones in Ashlar pattern with joint widths within tolerances indicated. Insert small stones into spaces between larger stones as needed to produce joints as uniform in width as practical.
- E. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.
- F. Set stone to comply with requirements indicated on Drawings. Install supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place. Set stone accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.

- G. Maintain uniform joint widths except for variations due to different stone sizes and where minor variations are required to maintain bond alignment if any. Lay walls with joints not less than **3/8 inch (10 mm)** at narrowest points or more than **5/8 inch (16 mm)** at widest points.
- H. Provide sealant joints of widths and at locations indicated.
1. Keep sealant joints free of mortar and other rigid materials.
 2. Sealing joints is specified in Section 07 9200 "Joint Sealants."
- I. Install metal expansion strips in sealant joints at locations indicated. Build flanges of expansion strips into masonry by embedding in mortar between stone masonry and backup wythe. Lap each joint **4 inches (100 mm)** in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
- J. Install embedded flashing and weep holes at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
1. At stud-framed walls, extend flashing through stone masonry, up sheathing face at least **8 inches (200 mm)**, and behind air barrier. Lap air barrier over flashing to seal penetrations.
 2. At multiwythe masonry walls, including cavity walls, extend flashing through stone masonry, turned up a minimum of **8 inches (200 mm)**, and extend into or through inner wythe to comply with requirements in Section 04 2200 "Concrete Unit Masonry."
 3. At concrete backing, extend flashing through stone masonry, turned up a minimum of **6 inches (150 mm)**, and insert in reglet. Reglets are specified in Section 07 6200 "Sheet Metal Flashing and Trim."
 4. At lintels and shelf angles, extend flashing full length of angles but not less than **6 inches (150 mm)** into masonry at each end.
 5. At sills, extend flashing not less than **4 inches (100 mm)** at ends.
 6. At ends of head and sill flashing, turn up not less than **2 inches (50 mm)** to form end dams.
 7. Extend sheet metal flashing **1/2 inch (13 mm)** beyond masonry face at exterior, and turn flashing down to form a drip.
- K. Place weep holes and vents in joints where moisture may accumulate, including at base of cavity walls, above shelf angles, and at flashing.
1. Use mesh weep holes/vents or open head joints to form weep holes.
 2. Space weep holes **24 inches (600 mm)** o.c.
 3. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.
- L. Install vents in head joints at top of each continuous cavity at spacing indicated. Use mesh weep holes/vents or open head joints to form vents.
1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.
- 3.4 CONSTRUCTION TOLERANCES
- A. Variation from Plumb: For vertical lines and surfaces, do not exceed **1/4 inch in 10 feet (6 mm in 3 m)**, **3/8 inch in 20 feet (10 mm in 6 m)**, or **1/2 inch in 40 feet (13 mm in 12 m)** or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed **1/4 inch in 20 feet (6 mm in 6 m)** or **1/2 inch in 40 feet (13 mm in 12 m)** or more.
- B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed **1/4 inch in 20 feet (6 mm in 6 m)** or **1/2 inch in 40 feet (13 mm in 12 m)** or more.

- C. Variation of Linear Building Line: For position shown in plan, do not exceed **1/2 inch in 20 feet (13 mm in 6 m)** or **3/4 inch in 40 feet (19 mm in 12 m)** or more.
- D. Measure variation from level, plumb, and position shown in plan as a variation of the average plane of each stone face from level, plumb, or dimensioned plane.
- E. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.
- F. Variation in Plane between Adjacent Stones: Do not exceed one-half of tolerance specified for thickness of stone.

3.5 INSTALLATION OF ANCHORED STONE MASONRY

- A. Anchor stone masonry to concrete with corrugated-metal veneer anchors unless otherwise indicated. Secure anchors by inserting dovetailed ends into dovetail slots in concrete.
- B. Anchor stone masonry to unit masonry with adjustable, screw-attached veneer anchors unless otherwise indicated. Fasten anchors to unit masonry with two screws.
- C. Anchor stone masonry to stud framing with adjustable, screw-attached veneer anchors unless otherwise indicated. Fasten anchors through sheathing to framing with two screws.
- D. Anchor stone masonry to stud framing with screw-attached veneer anchors unless otherwise indicated.
- E. Embed veneer anchors in mortar joints of stone masonry at least halfway, but not less than **1-1/2 inches (38 mm)**, through stone masonry and with at least a **5/8-inch (16-mm)** cover on exterior face.
 - 1. Install continuous wire reinforcement in horizontal joints and attach to seismic veneer anchors as stone is set.
- F. Space anchors not more than **16 inches (400 mm)** o.c. vertically and **24 inches (600 mm)** o.c. horizontally. Install additional anchors within **12 inches (300 mm)** of openings, sealant joints, and perimeter at intervals not exceeding **12 inches (300 mm)**.
- G. Space anchors not more than **18 inches (450 mm)** o.c. vertically and **32 inches (800 mm)** o.c. horizontally, with not less than one anchor per **2.67 sq. ft. (0.25 sq. m)** of wall area. Install additional anchors within **12 inches (300 mm)** of openings, sealant joints, and perimeter at intervals not exceeding **12 inches (300 mm)**.
- H. Anchor stone trim with stone trim anchors where indicated. Install anchors by fastening to substrate and inserting tabs and dowels into kerfs and holes in stone units. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with mortar.
- I. Set stone in full bed of mortar with full head joints unless otherwise indicated. Build anchors into mortar joints as stone is set.
- J. Fill space between back of stone masonry and weather-resistant sheathing paper with mortar as stone is set.
- K. Provide **1-inch (25-mm)** cavity between stone masonry and backup construction unless otherwise indicated. Keep cavity free of mortar droppings and debris.

1. Slope beds toward cavity to minimize mortar protrusions into cavity.
2. Do not attempt to trowel or remove mortar fins protruding into cavity.

- L. Rake out joints for pointing with mortar to depth of not less than **1/2 inch (13 mm)** before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

3.6 POINTING

- A. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply pointing mortar in layers not more than **3/8 inch (10 mm)** deep until a uniform depth is formed.
- B. Point stone joints by placing and compacting pointing mortar in layers of not more than **3/8 inch (10 mm)** deep. Compact each layer thoroughly and allow to it become thumbprint hard before applying next layer.
- C. Tool joints, when pointing mortar is thumbprint hard, with a smooth jointing tool to produce the following joint profile:
1. Joint Profile: Concave.

3.7 ADJUSTING AND CLEANING

- A. Remove and replace stone masonry of the following description:
1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Architect.
 2. Defective joints.
 3. Stone masonry not matching approved samples and mockups.
 4. Stone masonry not complying with other requirements indicated.
- B. Replace in a manner that results in stone masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.
- C. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 2. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before cleaning stone masonry.
 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
 4. Wet wall surfaces with water before applying cleaner; remove cleaner promptly by rinsing thoroughly with clear water.
 5. Clean stone masonry by bucket and brush hand-cleaning method described in BIA Technical Note No. 20, Revised II, using job-mixed detergent solution.

3.8 EXCESS MATERIALS AND WASTE

- A. Excess Stone: Stack excess stone where directed by Owner for Owner's use.
- B. Disposal as Fill Material: Dispose of clean masonry waste, including mortar and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than **4 inches (100 mm)** in greatest dimension.
 2. Mix masonry waste with at least 2 parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
 3. Do not dispose of masonry waste as fill within **18 inches (450 mm)** of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other waste, and legally dispose of off Owner's property.

END OF SECTION

SECTION 05 1200

STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS: The General Conditions, any Supplementary General Conditions and Division 1, General Requirements, are hereby made a part of this Section as fully as if repeated herein.
- 1.2 SECTION INCLUDES
- A. Structural Metals.
- 1.3 RELATED WORK
- A. Remaining metal work covered by Division 5.
- B. Concrete construction for the project is included in other subcontracts. Coordinate all details of structural metal fabrication and erection with the work of other Contractors.
- 1.4 QUALITY ASSURANCE
- A. Fabricator/Erector's Qualifications: Must have facilities and personnel sufficient to fabricate and erect structural metal framing as indicated on drawings; must have minimum of 5 years experience and be able, upon request, to show framing of similar size materials and scope of work of this contract; must be approved by the Structural Engineer.
- B. Material: Provide only structural steel certified as conforming with specified requirements and fabricated especially to the requirements of this contract.
- C. Tolerances: Unless otherwise noted on drawings or specified, provide structural steel work in accordance with the following minimum tolerances:
1. Fabrication Tolerances: In accordance with requirements of AISC Specifications.
 2. Erection Tolerances: Maximum deviation from plumb level and alignment shall not exceed AISC Specifications.
- D. Inspection: All tests and inspections required for shop and field quality control shall be performed by an inspection agency.
- E. Welders: Certified and qualified in accordance with requirements of the American Welding Society, for the particular materials and methods being used. The welder's certification papers shall be available on the first trip by the inspector.
- F. Welding Materials and Methods: For fabrication and erection shall be in accordance with the requirements of the American Welding Society.
- G. Codes and Standards: Comply with provisions of following, except as otherwise indicated:
1. AISC "Code of Standard Practice for Steel Buildings and Bridges".
 2. AISC "Specifications for the Design, Fabrications, and Erection of Structural Steel for Buildings" includes "Commentary" and Supplements thereto as issued.
 3. AISC "Specifications for Architecturally Exposed Structural Steel.

4. AISC "Specifications for Structural Joints using ASTM A-325 or A-490 Bolts" approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.
5. American Welding Society (AWS) D1.1 "Structural Welding Code - Steel".
6. ASTM A-6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use".

1.5 REFERENCES

- A. American Society for Testing and Materials (ASTM).
- B. American Institute of Steel Construction (AISC): "Manual of Steel Construction"
 1. Allowable Stress Design (ASD) - Ninth Edition
 2. Load and Resistance Factor Design (LRFD) - Third Edition
- C. Steel Structures Paint Council (SSPC): "Steel Structures Paint Manual, Volume 1 and Volume 2, Systems and Specifications, by Steel Structures Painting Council.

1.6 SUBMITTALS

- A. Shop Drawings: Submit prior to commencing any fabrication of structural metal; show dimensions, connections with adjoining materials and construction, finishes, welds, bolts, and fasteners, anchoring all fabrication or erection accessories required; show field welds, cuts, holes and fasteners; verify all dimensions and correlate with adjoining construction and materials; indicate size, type and grade of all members.
 1. Prior to the commencement of steel erection, the erector shall carefully inspect all anchor bolts and leveling plates installed under other subcontracts and shall notify the general contractor of defects. If the anchor bolt, leveling plate and base plate placement are acceptable to him he shall notify the general contractor of the same and proceed with erection of the structural steel.
 2. The approval of the shop drawings is limited to design intent only. No responsibility for a detailed check of member length, size, spacing, or similar detail information is assumed by the Structural Engineer by virtue of such approval.
- B. Shop drawings shall not be a reproduction of the contract drawings. Corrections or revisions to the shop drawings required to coordinate them with the contract documents and other shop drawings shall be made at no additional cost. **Please note that the Contract Documents in CADD format will not be made available to the contractor for their use in the preparation of the shop drawings, unless a release is signed, and a fee is paid for each cadd file requested.**
- C. All steel connection design shall be completed by a design professional hired by the contractor, and satisfy the load requirements specified in the contract documents. Prior to submission of steel shop drawings, the steel fabricator shall submit sample calculations (prepared by a registered structural engineer) for all typical beam to beam and beam to column connections, which are proposed to be used on this project. After these typical calculations and connections are accepted, the fabricator shall prepare and submit the shop drawings for this project. Only these typical sample calculations are required to be sealed by a registered structural engineer. The material necessary for the fabrication of all connections shall be the responsibility of the contractor.

D. Mill test reports - see paragraph 3.4.A.

1.7 PRODUCT HANDLING AND STORAGE

- A. Deliver to the project site materials to be installed by other contractors in time to be installed before the start of work by trade affected. Specifically, anchor bolts and other anchorage devices, which are embedded in cast-in-place concrete or masonry construction. Provide setting drawings, templates, and directions for the installation of the anchor bolts and other devices.
- B. Store all steel in such manner as to prevent distortion to the members and injury to the paint, and supported free from the ground and kept clean. Where shop coat becomes damaged during handling, touch up paint. In the event that the shop coat of paint is damaged or rusted due to storage, repaint steel prior to erection with same paint used as shop coat.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Plates, Angles, Channels, Bars, and rolled S, M, and HP shapes: ASTM A-36.
- B. Rolled Wide Flange Shapes: ASTM A-992, Grade 50.
- C. Cold-Formed Steel Tubing: ASTM A-500, Grade B.
- D. Hot-Formed Steel Tubing: ASTM A-501.
- E. Steel Pipe: ASTM A-53, Type E or S, Grade B.
- F. Anchor Bolts:
 - 1. ASTM F-1554 (hooked, headed, and threaded & nutted anchor rods including weldability supplement S1 conforming to grade 36).
- G. Bolts & Nuts:
 - 1. High-Strength Bolts, Nuts, and Washers: ASTM A-325 bolts, with ASTM A-563 nuts and ASTM F-436 washers.
 - 2. Tension Control Fastening System (conforming to ASTM F 1852) utilizing ASTM A-325 tension control bolts, nuts, and washers as manufactured by Unytite or approved equal.
- H. Electrodes for Welding: Comply with AWS Code.
 - 1. Covered mild steel electrodes complying with AWS Code and ASTM A-233, Series E70. Use E70 Series, Grade SAW-1 for welding ASTM A-36 steel. Use E70 Low Hydrogen Series, Grade SAW-2 for welding ASTM A-572, Grade 50 steel.
 - 2. All electrodes having low hydrogen type coverings shall be dried for at least 2 hours between 450 degrees F. and 500 degrees F. before they are used. Electrodes may be stored immediately after drying in storage ovens held at a temperature of at least 250 degrees F. Electrodes that are not used within 4 hours after removal from a drying or storage oven shall be redried before use. Electrodes which have been wet shall not be used.
- I. Structural Steel Primer Paint: Use one of the following:

1. No. 769 Grey Primer manufactured by Rust-Oleum Corporation.
 2. No. 99 Grey Primer manufactured by Tnemec Company.
 3. Wetsall Primer manufactured by Farboil Company.
 4. Or approved equal.
- J. Structural Steel Protective Coating: All structural steel exposed to the weather or embedded in exterior walls shall be hot-dip galvanized in accordance with ASTM A123-84.
- K. Non-Shrink Grout: CRD C-588, factory pre-mixed grout. Products are subject to compliance with requirements, provide one of the following Type D, Non-metallic grouts:
1. "Masterflow 713"; Master Builders
 2. "SonogROUT"; Sonneborn - Contect.
 3. "Euco-NS"; Euclid Chemical Company.
 4. "Five Star Grout"; U.S. Grout Company
 5. "DuragROUT"; L & M Construction Chemical Company

2.2 FABRICATION

- A. General: Fabricate items of structural steel in accordance with AISC Specifications and as indicated on the final shop drawings. Properly mark and matchmark all materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling. Provide camber in structural members where indicated.
- B. Temporary Field Connections: Temporary erection connections shall consist of at least one clip angle and two 3/4" diameter bolts, remote from or compatible with the field welded connections. The Contractor shall be responsible for the design, function and use of all temporary erection connections. Remove temporary connections if they interfere with architectural finishes.
- C. Permanent Field Connections: High-strength bolts, for use in permanent slip-critical or bearing type connections with threads in shear planes, shall conform to ASTM A-325.
1. Shear web connections: "Double angle connections" as described in Table 10-1, 10-2, & 10-3 of AISC Steel Construction Manual, LRFD Third Edition, with shop welds and permanent field high strength bolts. However, in no case shall the shear web connections be designed for less than the beam reactions shown in paragraphs 2.2.C.5 and 2.2.C.6 below, or as shown on the contract documents.
 2. Single angle connections may be used in the webs of beams, provided that the connection is designed for the eccentric load, except as otherwise noted on the drawings.
 3. Connections: Made with at least 3/4" diameter high strength bolts in slip-critical, pre-tension, or snug-tightened connections with threads in shear planes. All high-strength bolts shall be installed in accordance with Section 8.1 for snug-tightened connections, and section 8.2 for pre-tensioned and slip-critical connections of the AISC Specifications for Structural Joints Using ASTM A-325 or A-490 bolts, as approved by the Research Council on Structural Connections dated 06/23/2000. At all slip-critical connections, faying surfaces shall meet the requirements of section 3.2.2. All pre-tensioned bolts shall be twist-off type tension control bolt assemblies.
 4. Unless otherwise specified in the contract documents, all beam, joist, joist girder and column connections shall be as follows:
 - a. Beam to Beam Connections: Snug-tightened joints.
 - b. Beam to Column Connections: Snug-tightened joints.
 - c. Joist to Column Connections: Snug-tightened joints.

- d. Connections Subjected to Stress Reversal Conditions (Braced Frames, Moment Frames, etc.):
 - 1) Bolts In Standard Holes: Pre-tensioned joints.
 - 2) Bolts In Oversized or Slotted Holes: Slip-critical joints.
 - 5. All shear connections shall develop the end reaction (Ultimate LRFD Load) $\phi_b W_c / 2L$, where " $\phi_b W_c$ " is the uniform load constant in kip-foot, and where "L" is the span in feet, as shown in the tables "Uniform Load Constants for Beams" (laterally supported) for given shape and steel specified, LRFD Manual 3rd Edition, unless otherwise specified.
 - 6. All seated beam connections shall be designed so that the stiffener is clear of the finished ceiling and column encasement. The width of the stiffened seat shall not exceed 9". Beam web stiffeners shall be added as necessary to satisfy web yielding and web crippling code requirements.
- D. Holes for Other Work: Provide holes required for securing other work to structural steel framing and for the passage of other work through steel framing members as indicated. Provide threaded nuts welded to framing, and other specialty items as shown to receive other work.
- 1. Cut, drill or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.

2.3 SHOP PAINTING

- A. General: Shop paint all structural steel work, except members or portions of members to be embedded in concrete, mortar, or sprayed on fireproofing. Paint embedded steel on exposed portions and initial 2" of embedded areas only.
- 1. Do not paint contact surfaces which are to be welded or high-strength bolted.
 - 2. Apply a minimum of 2 coats of paint to surfaces, which are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
- B. Surface Preparation: After inspection and before shipping, clean steel work to be painted. Remove loose rust, loose mill scale and spatter, slag or flux deposits. Comply with Steel Structures Painting Council (SSPC) as follows:
- 1. SP-1 "Solvent Cleaning" for removing oil, grease and similar contaminates.
 - 2. SP-2 "Hand Tool Cleaning" for general cleaning.
 - 3. SP-3 "Power Tool Cleaning" for general cleaning.
- C. Application:
- 1. Immediately after surface preparation, apply structural steel primer paint in accordance with manufacturer's instructions and at a rate to provide a uniform minimum dry film thickness of 2.0 mils. Use painting methods which will result in full coverage of joints, corners, edges, and all exposed surfaces.
 - 2. Provide a one-coat shop applied paint system complying with Steel Structures Painting Council (SSPC)-Paint System Guide No. 7.00.
 - 3. Immediately after surface preparation, apply the hot-dip galvanizing in accordance with ASTM A123-84 at the coating weight required by Table 1 to provide a uniform mil dry film thickness of 3.4 mils. Use galvanized methods which will result in full coverage of joints, corners, edges and all exposed surfaces.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Erector must examine the areas and conditions under which structural steel work is to be installed including all anchor bolts and leveling plates installed under other contracts, and notify the Owner in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Erector.

3.2 ERECTION

- A. General: Comply with the AISC Specifications and Code of Standard Practice, and as herein specified. Maintain work in a safe and stable condition during erection.
 - 1. Structural steel with finished topcoat paint and galvanized steel shall be handled using nylon slings and wood dunnage to minimize damage.
- B. Anchor Bolts: Furnish anchor bolts and other connectors required for securing structural steel to foundations and other in-place work.
- C. Furnish templates and other devices as necessary for presetting bolts and other anchors to accurate locations.
 - 1. Refer to Division 3 sections for anchor bolts installation in concrete.
- D. Setting Leveling Plates:
 - 1. Clean concrete bearing surfaces and roughen to improve bond. Clean the bottom surface of leveling plates.
 - 2. Set loose leveling plates for structural members on wedges, or other adjusting devices.
 - 3. Tighten anchor bolts after the plates have been positioned and leveled to proper elevation. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the base plate prior to packing with grout.
 - 4. Pack grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.
- E. Temporary Shoring and Bracing: Provide, as required, with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of the structures as erections proceeds.
 - 1. Provide temporary planking and working platforms as necessary to effectively complete the work.
- F. Field Assembly: Set structural members to the lines and elevations indicated. Align and adjust the various members forming a part of a complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces which will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Splice members only where indicated.
 - 2. Do not enlarge unfair holes in members by burning or by the use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.
 - 3. Do not use gas cutting torches in the field for correcting fabrication errors in the structural framing. Cutting will be permitted only on secondary members which are not under stress as acceptable to the Structural Engineer. Finish gas-cut sections equal to a sheared

appearance when permitted.

G. Touch-Up Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of the shop paint, and paint all exposed areas with the same material as used for shop painting. Apply by brush or spray to provide the minimum dry film thickness as previously specified.
2. Steel which is abraded and rusty shall have primer and topcoat reapplied. Steel which is only abraded shall have topcoat reapplied.
3. Immediately after erection, clean field welds, bolted connections, and abraded areas of the hot-dip galvanized coating, and coat all exposed areas per ASTM A780-80. Apply coating to provide a minimum dry film thickness of 3.4 mils as previously specified.

H. Building Plumbness: The Contractor shall hire a registered surveyor to verify that the exterior perimeter structural steel columns have been installed within the tolerances specified by the AISC Commentary to the Code of Standard Practice for Buildings and Bridges - Section 7.13.1.1. A report shall be submitted to the architect for approval prior to final acceptance of the work.

3.3 SHOP AND FIELD WELDING

A. Welding: Where structural joints are made by welding, the details of all joints, the technique of welding employed, the appearance and quality of welds made and the methods used in correcting defective work shall conform to requirements of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings and the Structural Welding Code D1.1 of the American Welding Society. In addition welds shall be made only by operators who have been previously qualified by tests as prescribed in the Standard Qualification Procedure of the American Welding Society, to perform the type of work required. The Contractor shall pay all costs for the qualification of welders. All welding equipment shall be direct current reverse polarity type.

3.4 INSPECTION AND TESTING

- A. Mill Inspection: The Contractor shall furnish the inspection agency a copy of the certified mill test reports of the chemical analysis and physical tests for each member and each beam number.
- B. Shop Inspection: The Owner shall employ an inspection agency approved by the Structural Engineer to inspect the steel in the shop. This inspection shall include the joining of parts, punching, bolting, welding painting, etc. The inspection agency shall submit to the Structural Engineer, prior to the delivery of the steel to the job site, certified reports showing the results of these inspections. The shop inspection shall include the type and manufacturer of the paint used.
- C. Field Inspection: The Owner shall employ an inspection agency approved by the Structural Engineer to inspect the erected steel in the field. This inspection shall include alignment, position of member, bolting, welding, painting, etc. The inspection agency shall also submit to the Structural Engineer, prior to the Contractor's request for payment for the erected steel, certified reports showing results of these inspections.
- D. Costs: The cost of all the tests and inspections are to be borne by the Owner.
- E. Shop Inspection shall include, but is not limited to:

1. Examination of mill certificates in reference to material being fabricated.
 2. All welding procedures including certification of welders and electrode identification.
 3. All shop connections.
 4. Shop preparation for butt welds.
 5. Location of all clips, seats, holes and other accessories.
 6. Type and quality of shop paint and painting.
- F. Field Inspection shall include, but is not to be limited to:
1. See that all steel is properly stored and protected.
 2. Vertical and horizontal alignment of all beams and columns before and after welding.
 3. Temporary guying of building.
 4. All joints, prior to welding, for required clearances and preparation.
 5. Type of material and equipment used to make connections.
 6. Preheat requirements due to type of steel and weather conditions.
 7. All welded and bolted field connections.
 8. Check field touch-up painting prior to covering by architectural materials.
 9. Inspection shall mark all connections when they are finally approved.
 10. Welding of steel roof deck.
 11. Perform visual inspection of all welds.
 12. Perform tests of welds as follows:
 - a) Ultrasonic Inspection: ASTM E-164.
 - Locations: Full penetration welds
- G. Non-Destructive Testing: In addition to the visual inspection as indicated above, ultrasonic testing of 50% of groove welds shall be required. The testing shall be done using "Branson" ultrasonic testing equipment, or other approved non-destructive testing systems. If faulty welds are discovered by this testing, costs of any additional tests shall be borne by the Contractor.
- H. Reports: Mill certificates shall be reviewed and approved by the Inspection Agency and Structural Engineer prior to fabrication.
1. Certified shop inspection reports indicating that the steel as fabricated meets all the requirements of the Contract Documents shall be submitted to the Structural Engineer prior to shipment.
 2. Certified field reports, indicated that the steel as erected meets all of the requirements of the Contract Documents, shall be submitted to the Structural Engineer prior to starting of other work preventing access for any possible repairs.
- I. Notification: It shall be the responsibility of the Contractor to see that the inspection agency is supplied with a complete set of Contract Drawings and Specifications and approved shop drawings before the work is started. It shall be the Contractor's responsibility to notify the inspection agency before the start of fabrication and before the start of erection of steel, a sufficient time before such work is started in order that the inspector may properly schedule the required inspections. If material is shipped prior to shop inspection, any additional costs of inspection and repair shall be borne by Contractor.

3.5 CONTRACTOR'S RESPONSIBILITY

- A. Acceptance of the shop and field inspection done by the testing agency pertaining to the structural steel does not relieve the Contractor of his responsibility to insure that the project

has the proper sizes, strength, fabrication and erection procedures and any other requirements of the Contract Documents.

- B. If the installed structural steel is not erected in accordance with the contract documents and approved shop drawings, the contractor shall hire a professional engineer registered in the state of the project to prepare corrective calculations and details which shall be submitted to the engineer for approval prior to completing any corrections in the field. All costs incurred by the contractor to complete this corrective design and field repairs shall be paid by the contractor.
- C. Final Report: The Inspection Agency shall prepare a written report that summarizes the work inspected during the course of the project. A discussion of all deviations from the contract documents and specifications, with their related impact on the final construction, shall be described in detail. The engineer of record shall review this final report, and recommend corrective measures (as deemed necessary) that must be made prior to final acceptance of the work. Prior to final payment, a written report certifying that the work meets the requirements of the contract documents, specifications, and all governing agencies shall be prepared, submitted, and approved by the Architect.

END OF SECTION

SECTION 05 5000
METAL FABRICATIONS

Wood framing info is deleted – add back in from base where needed

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. Steel framing and supports for ceiling-hung toilet compartments.
2. Steel framing and supports for countertops.
3. Steel framing and supports for mechanical and electrical equipment.
4. Steel framing and supports for applications where framing and supports are not specified in other Sections.
5. Elevator machine beams, hoist beams.
6. Steel shapes for supporting elevator door sills.
7. Shelf angles.
8. Metal ladders.
9. Metal floor plate.
10. Elevator pit sump covers.
11. Metal bollards.
12. Metal downspout boots.
13. Loose bearing and leveling plates for applications where they are not specified in other Sections.

B. Products furnished, but not installed, under this Section:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Sections:

1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
3. Section 051200 "Structural Steel Framing."
4. Section 129300 "Site Furnishings" for bicycle racks.

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 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.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Paint products.
 - 2. Grout.
- B. Sustainable Design Submittals:
 - 1. [Product Data](#): For recycled content, indicating postconsumer and preconsumer recycled content and cost.
- C. 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. Steel framing and supports for operable partitions.
 - 2. Steel framing and supports for overhead doors.
 - 3. Steel framing and supports for countertops.
 - 4. Steel framing and supports for mechanical and electrical equipment.
 - 5. Elevator machine beams, hoist beams,.
 - 6. Steel shapes for supporting elevator door sills.
 - 7. Shelf angles.
 - 8. Metal ladders.
 - 9. Elevator pit sump covers.
 - 10. Loose steel lintels.
- D. Delegated-Design Submittal: For ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer.
- B. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.
- C. Welding certificates.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
- E. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls 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 acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, 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 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 of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- C. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- D. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.
- E. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- F. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- G. Rolled-Stainless-Steel Floor Plate: ASTM A 793.
- H. Steel Tubing: ASTM A 500, cold-formed steel tubing.

- I. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.
- J. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: As indicated.
 - 2. Material: Cold-rolled steel, ASTM A 1008/A 1008M, structural steel, **Grade 33 (Grade 230)**; **0.0677-inch (1.7-mm)** minimum thickness; unfinished.
- K. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
- L. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500.
- M. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

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 B 633 or **ASTM F 1941 (ASTM F 1941M)**, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless-steel fasteners for fastening stainless steel.
 - 2. Provide stainless-steel fasteners for fastening nickel silver.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, **ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6)**; with hex nuts, **ASTM A 563 (ASTM A 563M)**; and, where indicated, flat washers.
- C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, **ASTM F 593 (ASTM F 738M)**; with hex nuts, **ASTM F 594 (ASTM F 836M)**; and, where indicated, flat washers; Alloy Group **1 (A1)**.
- D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- E. Eyebolts: ASTM A 489.
- F. Machine Screws: **ASME B18.6.3 (ASME B18.6.7M)**.
- G. Lag Screws: **ASME B18.2.1 (ASME B18.2.3.8M)**.
- H. Wood Screws: Flat head, ASME B18.6.1.
- I. Plain Washers: Round, **ASME B18.22.1 (ASME B18.22M)**.
- J. Lock Washers: Helical, spring type, **ASME B18.21.1 (ASME B18.21.2M)**.
- K. Anchors, General: 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 E 488, conducted by a qualified independent testing agency.

- L. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- M. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or **ASTM F 1941** (**ASTM F 1941M**), 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 F 593** (**ASTM F 738M**), and nuts, **ASTM F 594** (**ASTM F 836M**).
- N. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, **1-5/8 by 7/8 inches (41 by 22 mm)** by length indicated with anchor straps or studs not less than **3 inches (75 mm)** long at not more than **8 inches (200 mm)** o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting," Section 099123 Interior Painting," and Section 099600 "High-Performance Coatings."
- C. 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.
- D. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- G. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- H. 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 will be 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 exterior framing and supports where indicated.
- D. Fabricate supports for operable partitions, overhead doors and ceiling braced toilet compartments from continuous steel beams of sizes recommended by partition manufacturer with attached bearing plates, anchors, and braces as recommended by partition manufacturer. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

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 shelf angles located in exterior walls.
- D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

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.
- B. Steel Ladders:
 - 1. Space siderails **18 inches (457 mm)** apart unless otherwise indicated.
 - 2. Space siderails of elevator pit ladders **12 inches (300 mm)** apart.
 - 3. Siderails: Continuous, **3/8-by-2-1/2-inch (9.5-by-64-mm)** steel flat bars, with eased edges.
 - 4. Rungs: **3/4-inch- (19-mm-)** diameter steel bars.
 - 5. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
 - 6. 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.
 - 7. 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.
 - 8. Support each ladder at top and bottom and not more than **60 inches (1500 mm)** o.c. with welded or bolted steel brackets.
 - 9. Galvanize exterior ladders, including brackets and fasteners.

2.9 ELEVATOR PIT SUMP COVERS

- A. Fabricate from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than **3/4 inch (19 mm)** in least dimension.
- B. Provide steel angle supports as 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 exterior miscellaneous steel trim.

2.11 METAL DOWNSPOUT BOOTS

- A. 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.
- B. Prime cast iron downspout boots with zinc-rich primer.

2.12 METAL BAR GRATINGS

- A. Rectangular Bar Grating:
 - 1. Traffic Surface: As indicated.
 - 2. Finish: Galvanized.
 - 3. Basis of Design: McNichols GW, Welded Rectangular Bar Grating.
- B. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.
 - 1. Provide not less than 4 saddle clips for each grating section composed of rectangular bearing bars 3/16 inch (4.8 mm) or less in thickness and spaced 15/16 inch (24 mm) or more o.c., with each clip designed and fabricated to fit over 2 bearing bars.
 - 2. Furnish threaded bolts with nuts and washers for securing grating to supports.
- C. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
- D. Do not notch bearing bars at supports to maintain elevation.

2.13 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 plates.

2.14 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 1/12 of clear span but not less than 8 inches (200 mm) unless otherwise indicated.
- C. Galvanize loose steel lintels located in exterior walls.

2.15 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.

2.16 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.
- C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.17 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M 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 railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - 1. Shop prime with primers specified in Section 099113 "Exterior Painting" and primers specified in Section 099123 "Interior Painting" unless indicated.

- D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
 - 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 Items: SSPC-SP 3, "Power Tool Cleaning."
- 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.

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 INSTALLING 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 ceiling hung toilet partitions operable partitions and overhead doors securely to, and rigidly brace from, building structure.

- C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
 - 1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.
- D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
 - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING 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 grout.
 - 1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 INSTALLING METAL BAR GRATINGS

- A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
- B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.
- C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.5 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

SECTION 05 5100

METAL STAIRS

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. Preassembled steel stairs with concrete-filled treads and wood finish materials.
- B. Related Sections:
 - 1. Section 033000 "Cast-in-Place Concrete" for concrete fill for stair treads and platforms.
 - 2. Section 055000 "Metal Fabrications" for metal treads and nosings installed at locations other than in metal stairs.
 - 3. Section 057300 "Decorative Metal Railings" for ornamental metal railings.
 - 4. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking for anchoring railings.
 - 5. Section 092216 "Non-Structural Metal Framing" for metal backing for anchoring railings.
 - 6. Section 06 2023 "Interior Finish Carpentry" for finish materials.

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 anchorages for metal stairs. 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.
- C. Coordinate locations of hanger rods and struts with other work so that they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.

1.4 ACTION SUBMITTALS

- A. Product Data: For metal stairs and the following:
 - 1. Wood treads.
 - 2. Prefilled metal-pan stair treads
 - 3. Abrasive nosings.
 - 4. 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. Samples for Verification: For the following products, in manufacturer's standard sizes:
 - 1. Wood Tread
 - 2. Abrasive nosings.
- E. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer and testing agency.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for stairs.

1.6 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, "Structural Welding Code - Sheet Steel."

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. [Alfab, Inc.](#)
 - 2. [American Stair, Inc.](#)
 - 3. [Lapeyre Stair Inc.](#)
 - 4. [Pacific Stair Corporation.](#)

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance of Stairs: Metal stairs shall 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 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.

2.3 METALS, GENERAL

- A. Metal Surfaces, General: 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. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.
- C. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- D. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513.
- E. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
- F. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25 (Grade 170), unless another grade is required by design loads; exposed.
- G. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, either commercial steel, Type B, or structural steel, Grade 30 (Grade 205), unless another grade is required by design loads.
- H. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating, either commercial steel, Type B, or structural steel, Grade 33 (Grade 230), unless another grade is required by design loads.
- I. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
- J. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

2.4 ABRASIVE NOSINGS

- A. Extruded Units: Aluminum units with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ACL Industries, Inc.
 - b. American Safety Tread Co., Inc.
 - c. Amstep Products.
 - d. Armstrong Products, Inc.
 - e. Balco, Inc.
 - f. Granite State Casting Co.
 - g. Nystrom, Inc.
 2. Provide solid-abrasive-type units without ribs.
 3. Nosings: Square-back units, **2 inches (50 mm)** wide, without lip, with abrasive filler in contrasting color ADA and Title 24 compliant.
- B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- C. Apply clear lacquer to concealed surfaces of extruded units set into concrete.

2.5 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or **ASTM F 1941 (ASTM F 1941M)**, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, **ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6)**; with hex nuts, **ASTM A 563 (ASTM A 563M)**; and, where indicated, flat washers.
- C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, **ASTM A 563 (ASTM A 563M)**; and, where indicated, flat washers.
 1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for stairs indicated to be galvanized.
- D. Post-Installed Anchors: Torque-controlled expansion anchors or 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 E 488/E 488M, conducted by a qualified independent testing agency.
 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or **ASTM F 1941 (ASTM F 1941M)**, 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 F 593 (ASTM F 738M)**, and nuts, **ASTM F 594 (ASTM F 836M)**.

2.6 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

- 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 D 1187.
- E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- F. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa) unless otherwise indicated.
- G. Nonslip-Aggregate Concrete Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.

2.7 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, struts, 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.
 - 3. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.
- B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- C. 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.
- 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 Type 1 welds: no evidence of a welded joint.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

- H. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.8 STEEL-FRAMED STAIRS

- A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.
 - 1. Preassembled Stairs: Commercial class.
 - 2. Ornamental Stairs: Architectural class.
- B. Stair Framing:
 - 1. Fabricate stringers of steel plates or channels at industrial and service stairs. Fabricate stringers of steel tubes at ornamental stairs
 - a. Provide closures for exposed ends of channel and tube stringers.
 - 2. Construct platforms of steel plate, channel or tube headers and miscellaneous framing members as needed to comply with performance requirements indicated.
 - 3. Weld stringers to headers; weld framing members to stringers and headers.
 - 4. Where stairs are enclosed by gypsum board assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.
 - 5. 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. Steel Sheet: Uncoated cold-rolled steel sheet unless otherwise indicated.
 - 2. Steel Sheet: Galvanized-steel sheet, where indicated.
 - 1. Directly weld metal pans to stringers; locate welds on top of subtreads where they are concealed by concrete fill. Do not weld risers to stringers.
 - 2. At Contractor's option, provide stair assemblies with metal pan subtreads filled with reinforced concrete during fabrication.
 - 3. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.
 - a. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.

2.9 STAIR RAILINGS

- A. Comply with applicable requirements in Section 057300 "Decorative Metal Railings."

2.10 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal stairs after assembly.

- C. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
 - 2. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed products:
 - 1. Exterior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Interior Stairs: SSPC-SP 3, "Power Tool Cleaning."
- E. 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 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. 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.
- 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. 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.
- F. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.
- G. 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. Center nosings on tread width.

3.2 ADJUSTING AND CLEANING

- A. Touchup Painting: 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.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 9123 "Interior Painting."
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

SECTION 05 7300

DECORATIVE METAL RAILINGS

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. Steel and iron decorative railings.
- B. Related Sections:
 - 1. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking for anchoring railings.
 - 2. Section 06 2023 "Interior Finish Carpentry" for wood railings.
 - 3. Section 09 2216 "Non-Structural Metal Framing" for metal backing for anchoring railings.

1.3 DEFINITIONS

- A. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor areas, pedestrian guidance and support, visual separation, or wall protection.

1.4 COORDINATION AND SCHEDULING

- 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.
- 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 items to Project site in time for installation.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not meet structural performance requirements.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Manufacturer's product lines of railings assembled from standard components.
 - 2. Grout, anchoring cement, and paint products.
- 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.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- D. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes.
- E. Samples for Verification: For each type of exposed finish required.
 - 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
 - 2. Fittings and brackets.
 - 3. Welded connections.
 - 4. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Samples need not be full height.
- F. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer and testing agency.
- B. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.
- C. Welding certificates.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.
- E. Preconstruction test reports.
- F. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.8 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

- B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Build mockups for each form and finish of railing consisting of two posts, top rail, infill area, and anchorage system components that are full height and are not less than **24 inches (600 mm)** in length.
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Steel and Iron Decorative Railings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Blum, Julius & Co., Inc.
 - b. Braun, J. G., Company; The Wagner Companies.
 - c. Lawler Foundry Corporation.
 - d. Livers Bronze Co.
 - e. VIVA Railings, LLC.
 - f. Wagner, R & B, Inc.
- B. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of railings and are based on the specific system indicated. See Section 01 6000 "Product Requirements."
 - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. Stainless Steel: 60 percent of minimum yield strength.
 - 2. Steel: 72 percent of minimum yield strength.
- C. Structural Performance: Railings shall 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.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, 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.

2.3 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: Same metal and finish as supported rails unless otherwise indicated.
 - 1. Provide either formed- or cast-metal brackets with predrilled hole for exposed bolt anchorage.

2.4 STEEL AND IRON

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Tubing: ASTM A 500 (cold formed) or ASTM A 513.
- C. Bars: Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
- D. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- E. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.5 FASTENERS

- A. Fastener Materials: Unless otherwise indicated, provide the following:
 - 1. Stainless-Steel Components: Type 304 stainless-steel fasteners.
 - 2. Uncoated Steel Components: Plated-steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed; Type 304 stainless-steel fasteners where exposed.
 - 3. Galvanized-Steel Components: Plated-steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
 - 4. Dissimilar Metals: Type 304 stainless-steel fasteners.
- B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

- C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless exposed fasteners are unavoidable.
 - 1. Provide square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. Anchors, General: 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 E 488, conducted by a qualified independent testing agency.
- E. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or **ASTM F 1941 (ASTM F 1941M)**, 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 F 593 (ASTM F 738M)**, and nuts, **ASTM F 594 (ASTM F 836M)**.

2.6 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- 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. Shop Primers: Provide primers that comply with Section 09 9113 "Exterior Painting" and Section 099123 "Interior Painting".
- E. Intermediate Coats and Topcoats: Provide products that comply with Section 09 9113 "Exterior Painting" and Section 099123 "Interior Painting."
- F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- G. 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 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.

2.7 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. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. 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.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. 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 Type 1 welds: no evidence of a welded joint.
- I. Form changes in direction as follows:
 - 1. By bending or by inserting prefabricated 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 end fittings.
- 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. Fabricate anchorage devices capable of withstanding loads imposed by railings. 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. For removable railing posts, fabricate slip-fit sockets from stainless-steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.
 - 1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.
- Q. 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.

2.8 GENERAL FINISH REQUIREMENTS

- 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 shipment.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. 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.

2.9 STEEL AND IRON FINISHES

- A. Galvanized Railings:
 - 1. Hot-dip galvanize exterior steel and iron railings, including hardware, after fabrication.
 - 2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
 - 3. Comply with ASTM A 153/A 153M 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.
- D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.
- E. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- F. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1:

Shop, Field, and Maintenance Painting of Steel," 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 indicated.
2. Do not apply primer to galvanized surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 2. Set posts plumb within a tolerance of **1/16 inch in 3 feet (2 mm in 1 m)**.
 3. 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 (5 mm in 3 m)**.
- 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.
- B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending **2 inches (50 mm)** beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within **6 inches (150 mm)** of post.

3.4 ANCHORING POSTS

- A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Cover anchorage joint with flange of same metal as post,.
- C. 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 stainless-steel railings, weld flanges to posts and bolt to metal-supporting surfaces.
 - 2. For steel railings, weld flanges to posts and bolt to metal-supporting surfaces.
- D. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.5 ATTACHING RAILINGS

- A. Attach handrails to walls with wall brackets. Provide brackets with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
 - 1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- B. Secure wall brackets to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 - 2. 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.

3.6 CLEANING

- A. Clean wood rails by wiping with a damp cloth and then wiping dry.
- B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.7 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

SECTION 05 7300

DECORATIVE METAL RAILINGS

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. Stainless-steel decorative railings

1.3 DEFINITIONS

- A. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor areas and for pedestrian guidance and support, visual separation, or wall protection.

1.4 COORDINATION AND SCHEDULING

- 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.
- 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 items to Project site in time for installation.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not meet structural performance requirements.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Manufacturer's product lines of railings assembled from standard components.
 - 2. Grout and anchoring cement.
- B. Shop Drawings: Include plans, elevations, sections, and attachment details.
- C. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes.
- D. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Fittings and brackets.
3. Welded connections.
4. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Samples need not be full height.

1.7 INFORMATIONAL SUBMITTALS

- A. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.
- B. Welding certificates.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.
- D. Preconstruction test reports.
- E. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.8 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 2. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 1. Build mockups for each form and finish of railing consisting of two posts, top rail, infill area, and anchorage system components that are full height and are not less than 24 inches in length.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls, stairs and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. 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. Performance characteristics

are indicated by criteria subject to verification by one or more methods, including structural analysis, preconstruction testing, field testing, and in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

2.2 PERFORMANCE REQUIREMENTS

- A. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 1. Steel: 72 percent of minimum yield strength.
 2. Stainless Steel: 60 percent of minimum yield strength.
- B. Structural Performance: Railings, including attachment to building construction, shall 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. applied in any direction.
 - b. Concentrated load of 200 lbf 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 applied horizontally on an area of 1 sq. ft..
 - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior railings by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.3 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: Same metal and finish as supported rails unless otherwise indicated.
 1. Provide either formed- or cast-metal brackets with predrilled hole for exposed bolt anchorage.

2.4 STAINLESS STEEL

- A. Tubing: ASTM A 554, Grade MT 304.
- B. Pipe: ASTM A 312/A 312M, Grade TP 304.
- C. Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20.
- D. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304.
- E. Bars and Shapes: ASTM A 276, Type 304.

2.5 STEEL AND IRON

- A. Tubing: ASTM A 500/A 500M (cold formed) or ASTM A 513.
- B. Bars: Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
- C. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- D. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.6 FASTENERS

- A. Fastener Materials: Unless otherwise indicated, provide the following:
 - 1. Stainless-Steel Components: Type 304 stainless-steel fasteners.
 - 2. Dissimilar Metals: Type 304 stainless-steel fasteners.
- B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless exposed fasteners are unavoidable.
 - 1. Provide tamper-resistant 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 Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.7 MISCELLANEOUS MATERIALS

- A. Wood Rails: Hardwood rails complying with Section 06 4300 "Wood Stairs and Railings."
- B. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- E. 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 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.

2.8 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. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. 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.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. 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 Type 1 welds; no evidence of a welded joint.
- I. Form changes in direction as follows:
 - 1. As detailed.
- 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 end fittings.
- 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.
- N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

2.9 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. 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.
- D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.10 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. Run grain of directional finishes with long dimension of each piece.
- C. Dull Satin Finish: No. 6.
- D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.11 STEEL AND IRON FINISHES

- A. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, but galvanize anchors to be embedded in exterior concrete or masonry.
- B. Powder-Coat Finish: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:
 - 1. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
 - 3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm).
 - 4. Color: Campus standard color, RAL-7022 Umbra Grey.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
 3. 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 (5 mm in 3 m).
- C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 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.
- B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

3.3 ANCHORING POSTS

- A. 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 or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Leave anchorage joint exposed with 1/8-inch (3-mm) buildup, sloped away from post.
- C. Anchor posts to pre-cast concrete surfaces with flanges and angle type as shown on panel, connected to posts and to metal supporting members as follows:
1. For steel railings, pre-weld flanges on posts and bolt to supporting surfaces.
 2. For steel railings, pre-weld flanges on posts set into CIP concrete footing.

3.4 ATTACHING RAILINGS

- A. Anchor railing ends to concrete and masonry with brackets on underside of rails connected to railing ends and anchored to wall construction with anchors and bolts.

3.5 CLEANING

- A. Clean aluminum and stainless steel by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.

3.6 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

SECTION 06 1000
ROUGH CARPENTRY

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 SECTION INCLUDES

- A. Blocking and nailers; plates, sills and curbs
- B. Exterior wall framing
- C. Wood grounds
- D. Mounting panels
- E. Interior Partition Framing including bulkheads and soffits
- F. Floor, Ceiling, and Roof Framing

1.3 RELATED WORK

- A. Section 03 3000 Cast-In-Place Concrete
- B. Section 04 2000 Unit Masonry
- C. Section 06 0573 Wood Treatment - All Structural Wood Framing & Sheathing
- D. Section 06 1600 Sheathing
- E. Section 06 1700 Prefabricated Structural Wood

1.4 QUALITY ASSURANCE

- A. Lumber Grading Rules and Wood Species: Agencies, Bureaus and Lumber Associations certified by Board of Review, American Lumber Standards Committee or Canadian Lumber Standards Administrative Board.
- B. Grade Marks: Identify lumber by official grade mark.
- C. Optional Framing: Certain requirements of bracing, notching, lapping or nailing may be waived in lieu of engineered connectors. Code approval and performance of connectors must be submitted to the engineer for approval.

1.5 REFERENCES

- A. ASTM – ASTM International

1. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
2. ASTM D 1761 Standard Test Methods for Mechanical Fasteners in Wood
3. ASTM D 3498 Standard Specification for Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems
4. ASTM D 5456 Standard Specification for Evaluation of Structural Composite Lumber Products
5. ASTM F 1667 Standard Specification for Driven Fasteners: Nails, Spikes, and Staples

B. American Forest and Paper Association

1. AFPA T01 National Design Specifications for Wood Construction
2. AFPA T03 Span Tables for Joists and Rafters
3. AFPA T05 Wood Structural Design Data
4. AFPA T10 Wood Frame Construction Manual for One and Two Family Dwellings
5. AFPA T11 Manual for Wood Frame Construction
6. AFPA WCD No. 1: Detail for Conventional Wood Frame Construction

C. APA – Engineered Wood Association

1. APA AFG-01 Adhesives for Field-Gluing Plywood to Wood Framing
2. APA E30 Engineered Wood Construction Guide
3. APA E830 Fastener Loads for Plywood – Screws
4. APA PRI-400 Performance Standard for APA EWS I-Joists
5. APA PRR-401 Performance Standard for APA EWS Rim Boards

D. National Bureau of Standards (NBS): NBS PS-20 American Softwood Lumber Standard

1. HIST PS-20 American Softwood Lumber Standard

E. Wood Associations:

1. Southern Pine Inspection Bureau (SPIB)
2. Western Wood Products Association (WWPA)
3. West Coast Lumber Inspection Bureau (WCLIB)
4. National Lumber Grades Authority (NLGA)
5. Northeastern Lumber Manufacturers Association (NELMA)

F. American Wood Preservers Association

1. AWPAC U1: Use Category System
2. AWPAC P5-86: Water Borne Preservative
3. AWPAC C1-86: Pressure Treatment (General Requirements)

G. American Institute of Timber Construction

1. AITC 112-93 Standard for Tongue-And-Groove Heavy Timber Roof Decking

1.6 SUBMITTALS

- A. Material Lists: Indicate selected wood species, stress ratings, grades and locations in the work.
- B. Manufacturers Literature: Types of rough hardware indicating size and material.

- C. Product Data: Engineered metal connectors, underlayment, insulating sheathing, air-infiltration barriers, construction adhesives; indicate locations.
- D. Samples: Rough hardware and fasteners for framing.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Protect materials from weather, humidity and moisture.
- B. Store materials 6-inches above ground on framework or blocking.
- C. Cover with waterproof covering, providing adequate air circulation.
- D. Protect sheet materials from broken and damaged surfaces and edges.

PART 2 – PRODUCTS

2.0 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded 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. 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 lumber.
 - 3. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.
- C. Engineered Wood Products: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
 - 1. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.1 MATERIALS - SOFTWOOD LUMBER

- A. Lumber dimensions indicated are nominal, actual dimensions per PS20.
- B. Surface four sizes (S4S), unless specified otherwise.
- C. Provide dry lumber with 19% maximum moisture content at time of dressing for 2" nominal thickness or less, unless otherwise indicated.

2.2 MATERIALS - SOFTWOOD BOARD LUMBER: PS-20, 1" to 1-1/2" thick; 2" to 12" wide

- A. Specie/Grade: WWPA, No. 4 Common; IWP, Utility; SPIB, No. 4; S-Dry or MC-19
 - 1. Locations: Concealed blocking and nailers; wood furring; wood grounds.
- 2.3 MATERIALS - SOFTWOOD DIMENSION LUMBER: PS-20
 - A. Structural Joists, Studs and Plates: S-Dry or MC-19
 - Specie Group - Spruce-Pine-Fir (NLGA); Grade, No.1/No.2 KD
 - Design Values - (psi) Fb=875; E=1400,000 modulus; Fc = 1150 parallel to grain
- 2.4 MATERIALS - SOFTWOOD DIMENSION LUMBER: MISCELLANEOUS
 - A. Specie/Grade: Any commercial softwood; Construction or No. 3 grade; S-Dry or MC-19.
 - 1. Locations: Miscellaneous framing; blocking and nailers; plates; sills and curbs.
- 2.5 MATERIALS – ENGINEERED WOOD PRODUCTS
 - A. Low Emitting Materials: Provide wood and Agrifiber products which contain no added ureaformaldehyde resins. LEED 2009 Credit MR7 [BCGBS Credit M7] and LEED 2009 IEQc4.4 [BCGBS Credit HB 4.4].
- 2.6 ACCESSORIES – SCREENING
 - A. Insect Screen: 18 x 14 mesh, fiberglass mesh.
 - 1. Locations: Behind exterior openings and vents.
- 2.7 ACCESSORIES - FASTENERS – SHEATHING
 - A. Nails and staples: As recommended by APA; (See Execution for Size).
 - 1. Locations: Plywood sheathing to wood framing
- 2.8 ACCESSORIES - FASTENERS - ROUGH CARPENTRY
 - A. Material and Size: Where rough carpentry is exposed to the weather, in ground contact or in areas of high relative humidity, all connection plates, angles, hangers, bolts, lag screws, nails, etc. shall be one of the following:
 - 1. Domestic steel shall be zinc plated or galvanized per ASTM A 153 or A653, class G185.
 - 2. Stainless steel shall conform to AISI Type 304.
 - B. Case Hardened Cut Nails: Size 8d for 1-inch thick wood; 10d for 2-inch thick wood; toe nailing increase by two sizes.
 - 1. Locations: Attachment of non-exposed wood to block masonry walls.
 - C. Common Nails: 8d for 1-inch thick wood; 12d for 2-inch thick; 40d for 3-inch thick; toe nailing increase by two sizes.
 - 1. Locations: Attachment of wood to wood.

- C. Expansion Shields: "Exp. Bolts" size minimum 1/2" bolt, shield length minimum 2-1/2".
 - 1. Locations: Attachment into masonry or cement products and materials with density in excess of 40 pcf.
- D. Lag Bolts/Screws: Minimum 1/2" diameter, with length 2 times material passed through.
 - 1. Locations: Attachment of assembled units to wood framing.
- E. Wood Screws: 6" long TimberLok self-drilling screws by FastenMaster or approved equal.
 - 1. Locations: Attachment of assembled units to wood framing
- F. Anchor bolts: 3/4" minimum 12" long with 2" hook end and 4" of thread.
 - 1. Locations: Embedment in masonry and concrete for blocking.
- G. Plate Washers: Size to accommodate fastener, minimum 3/4" outside diameter.
 - 1. Locations: Bolts and nuts (all types), penetrating wood or fiber board products.

2.9 ACCESSORIES - ADHESIVES - SHEATHING/SUBFLOORING/UNDERLAYMENT

- A. Polymeric-Latex Adhesive, Synthetic Rubber and Resin: APA spec AFG-01; One part gun grade, bleed resistant and non-staining; contain no oils, tar or asphalt; excellent water-resistance upon cure.
 - 1. Manufacturers:
 - a. DAP - Construction and Subfloor Adhesive
 - b. Macco/SCM Glidden - LN-602 Liquid Nails
 - 2. Locations: Plywood subflooring/underlayment to wood framing.

2.10 ACCESSORIES – SHIMS

- A. Material: Cedar shingles, slate, lead, galvanized steel or plastic.

2.11 ACCESSORIES - METAL FRAMING ANCHORS

- A. General: Provide galvanized steel framing anchors of structural capacity, type, and size required for installation of framing. Provide joist hangers, nail plates, post caps and base, metal cross bridging, framing anchors, L-straps, T-straps, header braces, plywood clips, etc., as indicated on drawings and as follows:
 - 1. Research or Evaluation Reports: Provide products for which model code research or evaluation reports exist that are acceptable to authorities having jurisdiction and that evidence compliance of metal framing anchors for application indicated with building code in effect for Project.
 - 2. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis, and demonstrated by comprehensive testing performed by a qualified independent testing agency.
- B. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653, G60

- (ASTM A 653M, Z180) coating designation; structural, commercial, or lock-forming quality, as standard with manufacturer for type of anchor indicated. For sheet steel fastened to preservative treated lumber, provide G185 coating.
- C. Joist Hangers: U-shaped joist hangers with 2-inch long seat and 1-1/4 inch wide nailing flanges at least 85 percent of joist depth.
 - 1. Thickness: 0.052 inch (18 gage) minimum.
 - D. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.
 - 1. Strap Width: 2 inches.
 - 2. Thickness: 0.052 inch (18 gage) minimum.
 - E. Bridging: Rigid, V-section, nailless type, 0.064 inch (16 gage) thick, length to suit joist size and spacing.
 - F. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post 1 inch above base and with 2-inch minimum side cover, socket 0.064 inch (16 gage) thick, standoff and adjustment plates 0.108 inch (12 gage) thick.
 - G. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.
 - 1. Width: 1-1/4 inches.
 - 2. Thickness: 0.064 inch (16 gage) minimum.
 - 3. Length: 16 inches.
 - H. Rafter Tie-Downs (Hurricane Ties): Bent strap tie for fastening rafters or roof trusses to wall studs below, 1-5/8 inches wide by 0.052 inch (18 gage) thick.
 - I. Floor-to-Floor Ties: Flat straps, with holes for fasteners, for tying upper floor wall studs to band joists and lower floor studs, 1-1/4 inches wide by 16 gage thick by length required by structural details – use CS16 coil strap by Simpson Strong Tie or approved equal.
 - J. Hold-Downs: Brackets for bolting to wall studs and securing to foundation walls with anchor bolts or to other hold-downs with threaded rods and designed with first of 2 bolts placed 7 bolt diameters from reinforced base, conforming to type HD7 by Simpson Strong Tie or approved equal.
 - K. Wall Bracing: T-shaped bracing made for letting into studs in saw kerf, 1-1/8 inches wide by 9/16 inch deep by 0.040 (20 gage) inch thick with hemmed edges.

2.12 ACCESSORIES - WOOD SEALER

- A. A clear deep penetrating water-repellent preservative compound for wood that is NWWDA-tested; contains 3-iodo-2-propynyl butyl carbonate (IPBC) as its active ingredient; reduces moisture penetration; serves as a primer and sealer for oil or water based paint systems; and protects against ultraviolet degradation, airborne dirt, smog, industrial fumes, acid rain and most other atmospheric chemical.
 - 1. Manufacturers: Tamms Industries Co. - "Chemstop Wood".
 - 2. Locations: Exterior plywood sheathing.

PART 3 - EXECUTION

3.1 PREPARATION - GENERAL CARPENTRY

- A. Verify dimensions and details before proceeding with the work.
- B. Coordinate locations of supports so that attached work will be secure and stable to support design loads of applicable wood specie.
- C. Verify location and use of treated lumber. Coat all cut surfaces of treated lumber with an approved preservative.

3.2 PREPARATION – FRAMING

- A. Advise installers of other work of the required limitations on notching and boring holes through wood frame members.
- B. Notches: Do not notch in end quarter or middle quarter of joists or rafters, and do not exceed 1/6 of depth of member for depth of notches in top or bottom of joists. Limit length of notches to 1/3 of depth of member.
- C. Holes: Do not bore holes closer than 2" from top or bottom of joists or rafters, and limit diameter to 1/3 of depth of member.

3.3 INSTALLATION - GENERAL CARPENTRY

- A. Utilize materials of longest practical lengths to prevent splicing.
- B. Do not use materials with warp, twist or bow in excess.
- C. Cut, scribe and cope for accurate fit.
- D. Set work accurately to required lines with members level, plumb and true with intersections to required angles.
- E. Shim to lines and levels with full-bearing.

3.4 INSTALLATION - ANCHORING AND FASTENING

- A. Securely attach wood products, to each other and to other materials, as indicated and as recommended by published standards.
- B. Make tight connections between members.
- C. Do not allow nails and screws to penetrate opposite sides which will be exposed to view or will receive finish.
- D. Install fasteners without splitting of wood; pre-drill pilot holes for sizes larger than 1/8".
- E. Do not hammer threaded fasteners; tighten without lubrication.
- F. Install load carrying components with appropriate devices.
- G. Set fasteners flush with surface; counter bore screws, nuts and bolts.

H. Nail or screw plywood in accord with APA publication E30A.

3.5 INSTALLATION - BLOCKING AND NAILERS, PLATES, SILLS AND CURBS

A. Softwood lumber or plywood in appropriate strength and size for use. No piece less than 6' long, unless indicated by dimensions. Anchor: Board lumber 2' on center, dimension lumber 4' on center, not less than 2 bolts.

1. Locations: Roof blocking for perimeters and penetrations. Also for secure fastening, stiffening, anchoring, hanging and attainment of various other profiles.

3.6 INSTALLATION - WOOD GROUNDS

A. Softwood lumber or plywood, minimum 3/4" thick x 6" wide; attached between studs.

1. Locations: Wall mounting in habited spaces (e.g., door stops, cabinets, shelving, rails, handicapped grab bars, toilet accessories, specialties and equipment furnished under other sections.)

3.7 INSTALLATION - WOOD FRAMING

A. Set accurately, plumb, level, and rigidly secured. Frame openings and comply with the AFPA WCD No. 1 and AFPA T11. Cut, join and tightly fit framing around other work. Do not splice structural members between supports unless otherwise detailed.

B. Anchor and nails in accord with the following Publications except where modified by other portions of this specification.

1. National Evaluation Report No. NER-272 for pneumatic or mechanical driven staples, P-Nails, and allied fasteners.
2. Published requirements of manufacturer of metal framing anchors.
3. Recommended Nailing Schedule of AFPA WCD No. 1 and AFPA T11.
4. "Table 2304.9.1 - Fastening Schedule" of the 2015 International Building Code.
5. Tables "R602.3 (1) Fastener Schedule for Structural Members" and "R602.3 (2) Alternate Attachments" of the 2015 International Residential Code.

C. Firestop in concealed spaces: Use wood blocking in concealed spaces of nominal 2-inch thickness, unless blocked by other framing members.

1. Stud walls (exterior or interior): Provide firestopping at each floor level and at top story ceiling level.
2. Floor and ceiling framing: Provide firestopping at ends of joists and over supports for full depth of joists.

D. Sill Plates: Provide where wood framing is supported by concrete or masonry walls or piers. Anchor to embedded bolts as shown.

3.8 INSTALLATION - STUD FRAMING: Including bulkheads and soffits

A. Studs:

1. Layout partition or wall on level deck.
2. Set wide face of stud perpendicular to face of wall or partition.

3. End nail studs through bottom and top plate.
 4. Erect walls complete with headers and jamb studs.
- B. Plates: Provide plates 2-inches thick and of same width as studs.
- C. Bottom Plates: Fasten bottom plate to deck near each end of partition or wall and at not more than 4' on center between ends. Anchor to wood with nails or lag bolts, to masonry and concrete with anchor bolts, expansion sleeves, or power driven fasteners.
- D. Single Top Plate: Permitted for non-loadbearing interior partitions.
- E. Double-Top Plates: Face nail upper top plate to lower top plate, over lap top plates at corners and intersections, stagger joints between plates.
- F. Corners and Intersection: Construct with minimum 3 studs 2-inches thick, providing bearing surface for wall finishes.
- G. Ends of Partitions Abutting Other Walls: Secure with fasteners located near each end of stud and maximum 4-feet on center.
- H. Openings: Frame with addition of jack studs (plus additional stud for openings wider than 6-feet) and double header members of thickness equal to width of studs. Set headers on edge and support on jack studs.
1. Openings in Exterior and Bearing Walls: Minimum header depth as required by AFPA T11 and the contract drawings.
 2. Non-bearing partitions: Minimum header depth of 4-inches for openings 3-feet and less in width and 6-inches deep for wider openings.
- I. Blocking and Struts: Provide minimum continuous horizontal row at mid-height of single story partitions over 8 feet high, and at midpoint between floors of multi-story partitions, using 2" thick members as the same width of studs.
- J. Grounds: Provide blocking and framing of same width as studs for support of facing materials, fixtures, specialty items including grab bars in all tub/shower units and trim.
- K. Gables: Except where truss framing is indicated on the drawings, frame gable end walls with studs cut to fit and toe nail to top plates of wall framing.

3.9 INSTALLATION - FLOOR FRAMING

- A. Fabricated truss framing is specified in section 06 1700
- B. Joists: Use members not less than indicated by AFPA T03 and the contract drawings. Install with crown edge up and support ends of each member with not less than 1-1/2" of bearing on wood or metal and not less than 3" of bearing on masonry.
- C. Double Joists: Provide beneath non-loadbearing partitions separated by solid blocking equal to width of studs above.
- D. Headers and Trimmers: Provide at openings and interruption of framing; double headers and trimmers where load bearing and/or where span of header exceeds 4'. Support joists with metal hangers countersunk top and bottom.
- E. Ends of Joists and Headers: Lap from opposite sides of beams, girders or bearing walls not

less than 4" and securely tie opposing members together.

1. Bearing on Wood: Attach to bearing members by toe nailing or metal connectors.
 2. Abutting other Wood: Frame to supporting members with nominal 2" wood ledgers, or with metal joist hangers.
 3. Built into Masonry: Fire-cut.
 4. Bearing on Masonry: Anchor with 1/4" x 1 1/4" metal strap or T-anchors.
 5. Bearing on Steel Framing: Minimum bearing 1 1/2". Provide nominal 2" sill plate bolted to steel with 1/2" bolts (ASTM A307) spaced at 24" o/c staggered.
- F. Blocking between Joists: Provide solid blocking under jamb studs at openings. Provide cross blocking for partitions parallel between joists. Support members at ends with solid blocking (unless nailed to a header or band member) and between members crossing over bearing point. Use blocking 2" thick by depth of joists.
- G. Bridging: Bridge between joists where nominal depth to thickness ratio exceeds 4:
1. Provide bridging as required by code, but minimum one center row bridging for spans over 10', and rows 8' on center for spans over 16'.

3.10 INSTALLATION - ROOF FRAMING

- A. Fabricated truss framing is specified in section 06 1700.
- B. Ridge: Provide ridge of same thickness as rafters and 2" deeper. Set plumb, level and straight for full length of roof.
- C. Rafters: Notch and bevel ends to fit wall plates, ridge or jack rafters. Toe nail or use framing anchors. Where rafters abut at ridge end nail through ridge. Place opposing rafters directly opposite each other and nail to ridge member.
- D. Double rafters at openings: Install headers and trimmers at openings and support with metal hangers. Bore 1" holes at side rafters above and below framed openings to allow air flow.
- E. Collar Beams: Provide minimum 2" x 6" boards between every pair of rafters. Locate below ridge member, one-third distance to joist, or at ceiling height. Cut ends to fit slope and nail to rafters.
- F. Valleys: Provide valley rafters twice as thick as regular rafters and 2 inches deeper. Bevel ends of jack rafters for full bearing against valley rafter.
- G. Hips: Provide hip rafters same thickness as regular rafters and 2" deeper. Bevel ends of jack rafters for full bearing against hip rafters.
- H. Bridging: Bridge between joists where nominal depth to thickness ratio exceeds 4: Provide bridging as required by code, but minimum one center row bridging for spans over 10', and rows 8' on center for spans over 16'.

3.11 INSTALLATION - PROTECTION OF FRAMING – BRACING

- A. Temporarily brace framing to maintain alignment, sustain winds and construction loads.
- B. Leave bracing in place until lateral stability is achieved with other design elements.

- C. Remove temporarily bracing when no longer required.

3.12 INSTALLATION - ROUGH CARPENTRY HARDWARE

- A. Where wood joists frame into beams, use 16 gauge standard joist hangers and 10d nails.
- B. All roof trusses with overhangs and all other horizontal surfaces exposed to wind uplift shall be secured to the building framing with 16 gauge hurricane anchors and 8 nails.

3.13 INSTALLATION - WOOD SEALER

- A. Surface must be structurally sound, clean, free of dust, mildew, peeling paint, wood resin and all other contaminants. The weather must be dry and suitable for application, and the substrate dry for a minimum 3-5 days before application.
- B. All caulking and sealants must be installed prior to application of sealer.
- C. Sealer must be applied using airless spray equipment.
- D. All wood surfaces shall be sealed with one application coat which consists of a light fogging spray, followed immediately with a flood coat to achieve the deep penetration required for waterproofing. Allow 48 hours drying time.

3.15 INSPECTION

- A. The Owner shall employ and pay for the services of an independent Inspection Agency, acceptable to the Structural Engineer, to perform a field review of the installation of the structural wood framing.
- B. Field inspection shall include but is not limited to the following:
 - 1. Size, species and spacing of all stud bearing walls, floor joists and roof rafters.
 - 2. Alignment of all roof, floor and wall framing.
 - 3. Installation of all headers, jambs, lintels and other framing at openings.
 - 4. Bridging and blocking installation between trusses, rafters and stud members.
 - 5. All connections between individual framing members including beam to beam, joist to beam, beam to column and truss to beam/wall. These connections include nailing of plywood to framing members as well as installation of hurricane anchors, steel plate connections and other framing details.
 - 6. Installation of all structural use panels and gypsum sheathing at shearwalls.

3.16 CONTRACTOR'S RESPONSIBILITY

- A. Submit copies of all reports indicating conformance and exceptions to contract documents in a timely fashion to General Contractor for distribution to design consultants, owner, subcontractors and other interested parties.
- B. Final Report: The Inspection Agency shall prepare a written report that summarizes the work inspected during the course of the project, and certifies that the work meets the requirements of the contract documents, specifications, and all governing agencies.

END OF SECTION

SECTION 06 1053

MISCELLANEOUS ROUGH CARPENTRY

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. Framing with dimension lumber.
 - 2. Rooftop equipment bases and support curbs.
 - 3. Wood blocking, cants, and nailers.
 - 4. Wood furring and grounds.
 - 5. Plywood backing panels.
- B. Related Requirements:
 - 1. Section 061600 "Sheathing."

1.3 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) or greater size but less than 5 inches nominal (114 mm actual) size in least dimension.

1.4 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 according to ASTM D 5664.
 - 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
 - 1. Preservative-treated wood.
 - 2. Fire-retardant-treated wood.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber 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, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded 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.
 - 3. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
 - 2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or 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.
- D. Application: Treat items indicated on Drawings, and the following:
 - 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - 2. Wood sills, sleepers, blocking, furring, and similar concealed members in contact with masonry or concrete.
 - 3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
 - 4. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
 - 5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, use materials complying 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 according to ASTM E 84, 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. Use treatment that does not promote corrosion of metal fasteners.
 - 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
 - 3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
 - 4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D 5664, and design value adjustment factors shall be calculated according to ASTM D 6841. For enclosed roof framing, framing in attic spaces, and where high temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to 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 inspection agency.
- E. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
- F. Application: Treat items indicated on Drawings, and the following:
 1. Framing for raised platforms.
 2. Concealed blocking.
 3. Roof framing and blocking.
 4. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
 5. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 1. Blocking.
 2. Nailers.
 3. Cants.
 4. Furring.
 5. Grounds.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.
 1. Hem-fir (north); NLGA.
 2. Hem-fir; WCLIB or WWPA.
 3. Western woods; WCLIB or WWPA.
- C. For concealed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
 1. Hem-fir or hem-fir (north), Standard or No. 3 Common grade; NLGA, WCLIB, or WWPA.
 2. Western woods, Standard or No. 3 Common grade; WCLIB or WWPA.
- 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.
- E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: DOC PS 1, Exterior, AC, fire-retardant treated, in thickness indicated or, if not indicated, not less than **3/4-inch (19-mm)** nominal thickness.

2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Where 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 A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Screws for Fastening to Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.
- D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 or ICC-ES AC193 as appropriate for the substrate.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material: Stainless steel with bolts and nuts complying with **ASTM F 593 and ASTM F 594, Alloy Group 1 or 2** (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

2.7 METAL FRAMING ANCHORS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. [Cleveland Steel Specialty Co.](#)
 - 2. [KC Metals Products, Inc.](#)
 - 3. [Phoenix Metal Products, Inc.](#)
 - 4. [Simpson Strong-Tie Co., Inc.](#)
- B. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, **G60 (Z180)** coating designation.
 - 1. Use for interior locations unless otherwise indicated.
- C. Stainless-Steel Sheet: ASTM A 666, Type 304.
 - 1. Use for exterior locations and where indicated.

2.8 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
 - 1. Adhesives shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall 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. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum

foil, or spunbonded polyolefin to produce an overall thickness of not less than **0.025 inch (0.6 mm)**.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- C. 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.
- D. Metal Framing Anchors: Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- E. Do not splice structural members between supports unless otherwise indicated.
- F. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than **16 inches (406 mm)** o.c.
- G. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
 - 1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than **96 inches (2438 mm)** o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
 - 2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than **96 inches (2438 mm)** o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and **2-inch nominal (38-mm actual)** thickness.
 - 3. Fire block concealed spaces behind combustible cornices and exterior trim at not more than **20 feet (6 m)** o.c.
- H. Sort and select lumber so that natural characteristics will 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.
- I. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.

- J. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- K. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 - 2. ICC-ES evaluation report for fastener.
- L. 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 WOOD BLOCKING, AND NAILER INSTALLATION

- 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 items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than **1-1/2 inches (38 mm)** wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 WOOD FURRING INSTALLATION

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood or Hardboard Paneling: Install **1-by-3-inch nominal-size (19-by-63-mm actual-size)** furring horizontally and vertically at **24 inches (610 mm)** o.c.
- C. Furring to Receive Gypsum Board: Install **1-by-2-inch nominal-size (19-by-38-mm actual-size)** furring vertically at **16 inches (406 mm)** o.c.

3.4 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.
- B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 061600

SHEATHING

A. GENERAL

A.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.

A.2 SUMMARY

- A. Section Includes:
 - 1. Wall sheathing.
 - 2. Roof sheathing.
 - 3. Parapet sheathing.
 - 4. Subflooring.
 - 5. Sheathing joint and penetration treatment.
- B. Related Requirements:
 - 1. Section 06 1053 "Miscellaneous Rough Carpentry" for plywood backing panels.

A.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 plywood complies 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 plywood complies with requirements. Include physical properties of treated materials.
 - 3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.
 - 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 Certificates](#): For certified wood products. Include statement of costs.
 - 2. [Chain-of-Custody Qualification Data](#): For manufacturer and vendor.
 - 3. [Product Data](#): For composite wood products, indicating that product contains no urea formaldehyde.

4. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
5. Product Data: For installation adhesives, indicating VOC content.

A.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For following products, from ICC-ES:
 1. Preservative-treated plywood.
 2. Fire-retardant-treated plywood.

A.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
- B. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.
- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution:
 1. Provide Mock-up Panel as indicated on drawings and as detailed in Division 4 Section Exterior Stone Cladding.
 - a. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
 - b. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
 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.

A.6 REFERENCES

- A. American Plywood Association (APA)
 1. APA PS-1 Construction and Industrial Plywood (ANSI A199.1)
 2. APA E30A Design/Construction Guide - Residential and Commercial
- B. APA – Engineered Wood Association
 1. APA AFG-01 Adhesives for Field-Gluing Plywood to Wood Framing
 2. APA E30 Engineered Wood Construction Guide
 3. APA E830 Fastener Loads for Plywood – Screws

4. APA PS-2 Performance Standards for Wood-Based Structural-Use Panels
5. APA T325 Roof Sheathing Fastening Schedules for Wind Uplift

A.7 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

B. PRODUCTS

B.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: As tested according to ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

B.2 WOOD PANEL PRODUCTS

- A. Emissions: Products shall 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. **Certified Wood**: The following wood products shall be certified as "FSC Pure" according to FSC STD-01-00 and FSC STD-40-004.
 1. Plywood.
- C. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
- D. Factory mark panels to indicate compliance with applicable standard.

B.3 PRESERVATIVE-TREATED PLYWOOD

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2.
 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

- C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

B.4 FIRE-RETARDANT-TREATED PLYWOOD

- A. General: Where fire-retardant-treated materials are indicated, use materials complying 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 Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, 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. Use treatment that does not promote corrosion of metal fasteners.
 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
 3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
 4. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D 5516 and design value adjustment factors shall be calculated according to ASTM D 6305. Span ratings after treatment shall be not less than span ratings specified. For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to **170 deg F (76 deg C)** shall be not less than span ratings specified.
- C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.
- E. Application: Treat plywood indicated on Drawings, and the following:
1. Roof and wall sheathing within **48 inches (1220 mm)** of fire walls.
 2. Roof sheathing as indicated.
- F. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [CertainTeed Corporation; GlasRoc.](#)
 - b. [G-P Gypsum Corporation; Dens-Glass Gold.](#)
 - c. [National Gypsum Company; Gold Bond e\(2\)XP.](#)
 - d. [United States Gypsum Co.; Securock.](#)
 2. Type and Thickness: Regular, **1/2 inch (13 mm)** thick.
 3. Size: **48 by 96 inches (1219 by 2438 mm)** for vertical installation.

B.5 ROOF SHEATHING

- A. Plywood Roof Sheathing: Either DOC PS 1 or DOC PS 2, Exterior sheathing.
 - 1. Span Rating: Not less than 16/0.
 - 2. Nominal Thickness: Not less than ¾ inch.

B.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. For roof parapet and wall sheathing, provide fasteners of Type 304 stainless steel.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Screws for Fastening Sheathing to Wood Framing: ASTM C 1002.
- E. Screws for Fastening Gypsum Sheathing to Wood Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
 - 1. For steel framing less than 0.0329 inch (0.835 mm) thick, use screws that comply with ASTM C 1002.
 - 2. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, use screws that comply with ASTM C 954.

B.7 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
 - 1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches (50 mm) wide, 10 by 10 or 10 by 20 threads/inch (390 by 390 or 390 by 780 threads/m), of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

B.8 MISCELLANEOUS MATERIALS

- A. Adhesives for Field Gluing Panels to Framing: Formulation complying with ASTM D 3498 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.
 - 1. Adhesive shall 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."
2. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. EXECUTION

C.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
 1. NES NER-272 for power-driven fasteners.
 2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
- D. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

C.2 WOOD STRUCTURAL PANEL INSTALLATION

- A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
- B. Fastening Methods: Fasten panels as indicated below:
 1. Subflooring:
 - a. Screw to framing.
 - b. Space panels **1/8 inch (3 mm)** apart at edges and ends.
 2. Wall and Roof Sheathing:
 - a. Screw to framing.
 - b. Space panels **1/8 inch (3 mm)** apart at edges and ends.

C.3 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
 - 1. Fasten gypsum sheathing to framing with screws.
 - 2. Install boards with a **3/8-inch (9.5-mm)** gap where non-load-bearing construction abuts structural elements.
 - 3. Install boards with a **1/4-inch (6.4-mm)** gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
- C. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
 - 1. Space fasteners approximately **8 inches (200 mm)** o.c. and set back a minimum of **3/8 inch (9.5 mm)** from edges and ends of boards.
- D. Seal sheathing joints according to sheathing manufacturer's written instructions.
 - 1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
 - 2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel silicone emulsion sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

END OF SECTION

SECTION 06 1700

SHOP-FABRICATED STRUCTURAL WOOD

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Engineered and Fabricated wood trusses.
- B. Treated sill and sole plates (TimberStrand LSL)

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. Section 06 0573 Wood Treatment
- C. Section 06 1000 Rough Carpentry
- D. Section 06 1600 Sheathing

1.3 REFERENCES: Comply with the applicable requirements

- A. ASTM – American Society for Testing and Materials
 - 1. ASTM A 591 Standard Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Mass Applications
 - 2. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- B. National Bureau of Standards (NBS):
 - 1. NBS PS-20 American Softwood Lumber Standard
- C. American Forest and Paper Association
 - 1. AFPA T03 Span Tables for Joists and Rafters
 - 2. AFPA T05 Wood Structural Design Data
 - 3. AFPA T11 Manual for Wood Frame Construction
 - 4. AFPA T901 National Design Specifications for Wood Construction
- D. National Lumber Grades Authority (NLGA), A Canadian Agency
- E. NIST – National Institute of Standards and Technology
 - 1. NIST PS-20 American Softwood Lumber Standards
- F. Truss Plate Institute (TPI):
 - 1. ANSI/TPI 1-2007 – National Design Standard for Metal Plate Connected Wood Truss Construction
 - 2. TPI/SBCA – Building Component Safety Information, BCSI: Guide to Good Practice for Handling, Installing, Restraining & Bracing of Metal Plate Connected Wood

Trusses

3. TPI DSB-89 - Temporary Bracing of Metal Plate Connected Wood Trusses.

G. American Society for Testing and Materials (ASTM)

H. National Forest Products Association (NFPA):

1. NFPA National Design Specifications for Wood Construction

I. American Institute of Timber Construction (AITC)

J. American Plywood Association (APA)

K. American Wood Preservers Association (AWPA)

L. Council of American Building Officials (CABO)

M. Occupational Safety & Health Administration (OSHA)

N. International Code Council (ICC)

1. International Building Code (IBC)

1.4 DEFINITIONS

A. Definition: Fabricated wood trusses include planar structural units consisting of metal plate connected members which are fabricated from dimension lumber and which have been cut and assembled prior to delivery to the job site. Types of fabricated wood trusses include:

1. Gable-shaped trusses.
2. Scissors trusses.
3. Monopitch trusses
4. Floor Trusses

1.5 QUALITY ASSURANCE

A. Truss Plate Institute (TPI) – Comply with all publications referenced in paragraph 1.3.F.

B. Wood Structural Design Standard: National Design Specification for Wood Construction published by N.F.P.A.

C. Grading of Lumber: Provide lumber graded by a recognized agency, with rules and service complying with requirements of American Lumber Standards Committee, APA and PS 20. Use only lumber pieces which bear inspection service's grade mark, unless otherwise indicated. (Remove mark during fabrication if necessary).

D. Standards: Except as otherwise indicated, comply with APA, AWPA and CABO for "Parallel Strand Lumber" (PSL) and "Laminated Veneer Lumber" (LVL).

F. Fabricator's Qualifications: Minimum of 3 years experience in successful fabrication of trusses comparable to type indicated for this project. The truss manufacturer shall be a member of TPI Inplant Inspection Program or other third party inspection program.

G. Grade Marks:

1. Identify lumber and plywood by official grade mark.
2. Factory mark each piece of LVL and PSL units with APA and AWPA Quality Inspection mark. Place APA and AWPA mark on timber surfaces which will not be exposed in completed work.

H. Treated Products:

1. Kiln-dry waterborne treated products to a mixture not to exceed 19 percent.
2. Increase required stress ratings by 10 percent for fire-retardant treated wood.

1.6 REGULATORY REQUIREMENTS

- A. Design and fabricate Wood Trusses under direct supervision of a Professional Engineer experienced in the design of structures, registered in the State of Maryland.
- B. Conform to IBC 2015 Code and References.

1.7 SUBMITTALS

A. Designing and Engineering Data:

1. Indicate lumber species and stress grades of lumber, type of glue and other variables in required work
2. Provide drawings showing configurations, pitch, span and location of trusses.
3. Provide large scale details of metal connectors at joints and installation anchorages.
4. Include stress diagrams and engineering calculations.
5. Include the name and seal of the Professional Engineer (designing the trusses) on each sheet.
6. Product Data: Submit manufacturer's data, specifications and installations instructions covering lumber, adhesives, fabrication process, accessories and protection.
7. Shop Drawings: Show dimensional shapes keyed to project locations.

- B. Samples: Submit samples, 24 inches long x full width x depth, showing range of variation expected in appearance of PSL units, including specified treatment, if any. Samples will be reviewed by Architect for color, pattern and texture only.

C. Certification:

1. Written certification that truss manufacturer is a member of the TPI Inplant Inspection Program or other third-party inspection program.
2. Written certification that the trusses as fabricated and erected are in complete compliance with the contract drawings and specifications and quality manufacturing standards of TPI.

1.8 PRODUCT HANDLING, DELIVERY AND STORAGE

- A. Handle and store trusses LVL's and PSL's with care, and in accordance with manufacturer's instructions and TPI recommendations to avoid damage from bending, overturning or other cause for which truss is not designed to resist or endure.

PART 2 - PRODUCTS

2.1 DESIGN LOADS

- A. All floor and roof trusses shall be designed for the following minimum superimposed live and dead loads beyond the self weight of the wood structure.
1. Floor Trusses:
 - Top Chord:
 - Live Load = 50 psf
 - Dead Load = 15 psf
 - Dead Load = parallel non-bearing stud partitions
 - Bottom Chord:
 - Dead Load = 5 psf
 2. Roof Trusses:
 - Top Chord:
 - Live Load = 30 psf
 - Drifting Snow per IBC 2015 and ASCE 7-10
 - Dead Load = 15 psf
 - Dead Load of all mechanical equipment shown on the contract drawings.
 - Wind Load = 115 mph per IBC 2015 and ASCE 7-10,
 - Bottom Chord:
 - Dead Load = 10 psf
 - Dead Load of all mechanical equipment shown on the contract drawings
 3. All floor trusses shall be designed so that the maximum live load deflection is less than the span in inches divided by 480 (L/480). All roof trusses shall be designed so that the maximum live load deflection is less than the span in inches divided by 360 (L/360) or 1" whichever is less.
 4. Truss bracing for chord and web members shall meet the following requirements.
 - a. Additional truss bracing beyond that shown on the drawings shall be provided as necessary in order to assure adequate bracing of truss members.
 - b. Bracing between trusses chords and webs must be perpendicular to the member being braced.
 - c. All bracing shall be continuous between a minimum of 4 trusses.
 - d. Bracing forces at the end of all bracing lines shall be transferred to the top and bottom roof diaphragms by cross bridging.
 - e. If inadequate truss bracing exists in the plane of the top and bottom chord of the trusses, the contractor shall design and install all required bracing to assure the truss lateral forces are adequately transferred to the building's main force resisting system.
 - f. If bracing cannot be installed as required above, the truss chord and web members shall be strengthened to eliminate the need for supplemental bracing.
- 2.2 MATERIALS: SOFTWOOD DIMENSION LUMBER: PA-20:
- A. Structural Light Framing or Structural Joists and Planks
 1. Specie Group-Any commercial Softwood
 2. Grade- MSR (Machine Stress Rated)
 3. Design Values $F_b=1600$ psi single (minimum)
- 2.3 ACCESSORIES: FASTENERS, METAL CONNECTOR PLATES, AND ANCHORAGES
- A. Connector Plate Material: Metal complying with following requirements, unless otherwise indicated; not less than "0.036" thick, coated thickness (Contractors option if more than one metal indicated).

1. Galvanized Sheet Steel: ANSI/ASTM A 653, Grade A, Coating G60 / G185.
 2. Electrolytic Zink Coated Steel Sheet: ANSI/ASTM A 591, Coating Class C, with minimum structural quality equivalent to ANSI/ASTM A 653, Grade A.
 3. Stainless Steel: ANSI/ASTM A 167, Type 304, with minimum structural quality equivalent to ANSI/ASTM A 446, Grade A.
- B. Fasteners and Anchorages: Provide size, type, material and finish indicated, complying applicable Federal Specifications for nails, screws, bolts, nuts and washers and anchoring devices.
- C. Provide fabricated steel (ANSI/ASTM A 36) shapes, plates and bars, welded into assemblies of types and sizes indicated or, if not indicated, manufacturer's standard units for timber sizes indicated, with steel bolts (ANSI/ASTM A 307), lab bolts (FS FF-B-561), nails (FS FF-N-105), and other standard fasteners as required.
- D. Except as otherwise indicated, finish fabricated assemblies with rust-inhibitive primer.

2.4 FABRICATION: WOOD TRUSSES

- A. Cut truss members to accurate lengths, angles and sizes to produce close fitting joints with proper wood-to-wood bearing in assembled units.
- B. Fabricate metal connector plates to proper size, configuration, thickness and anchorage details required for type of joint designed.
- C. Assemble truss members in design configuration indicated using jigs or other means to ensure uniformity and accuracy of assembly. Position members to produce design camber indicated.
- D. Connect truss members by means of metal connector plates accurately located and securely fastened to wood members.
- E. The Contractor shall submit written verification that wood truss industry documents referenced in paragraph 1.3.F have been received, reviewed, and incorporated into this project prior to truss installation. All bracing and related components required by these documents which are not shown on the contract documents shall be added to the project at no change in contract price.

PART 3 - EXECUTION

3.1 INSTALLATION: WOOD TRUSSES

- A. Erect trusses in accord with recommendations of manufacturer and The TPI. Set with webs vertical (plumb) and parallel to each other, located at design spacings indicated.
- B. Hoist units in place by means of proper lifting equipment suited to sizes and types of trusses required, applied at proper lift points as recommended by fabricator, exercising care not to damage truss members or joints by out-of-plane bending or other causes.
- C. Temporarily brace trusses in accordance with The TPI to maintain trusses plumb, parallel and in proper location, until permanent bracing is installed.
- D. Anchor trusses securely at bearing points to comply with design and details indicated.

- E. Install permanent bracing and related components to enable trusses to maintain design (including lateral loads) and spacing, withstand live and dead loads, per The TPI.
 - 1. Provide 2x6 "strong back" bracing perpendicular to truss span, not to exceed 7'-0" on center, secured to truss web with 2-10d nails. Where "strong backs" are cut for ductwork, provide additional bracing.
- F. Do not cut or remove truss members.

3.2 INSPECTION

- A. The Owner shall employ and pay for the services of an independent Inspection Agency, acceptable to the Structural Engineer, to perform a field review of the installation of the prefabricated wood trusses.
- B. Field Inspection shall include but is not limited to the following:
 - 1. Size, species and layout of all chords and diagonals of the individual wood trusses including all gangnail plate installation.
 - 2. Inspection of trusses to assure that they have not been mishandled during shipping and erection.
 - 3. Installation of all permanent and temporary bridging, strut bracing, and stiffbacks required by the contract documents and truss shop drawings.
 - 4. All other fabrication and erection requirements as stipulated by the Truss Plate Institute.
 - 5. Installation of all permanent connections required by the contract documents and shop drawings.
 - 6. All other fabrication and erection requirements as stipulated by the manufacturer.

3.3 CONTRACTOR'S RESPONSIBILITY

- A. Submit copies of all reports indicating conformance and exceptions to contract documents in a timely fashion to General Contractor for distribution to design consultants, owner, subcontractors and other interested parties.
- B. Final Report: The Inspection Agency shall prepare a written report that summarizes the work inspected during the course of the project, and certifies that the work meets the requirements of the contract documents, specifications, and all governing agencies.

END OF SECTION

SECTION 06 2023

INTERIOR FINISH CARPENTRY

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. Standing and Running trim.
2. Interior Hardwood Handrails
3. Flush Wood-Veneer-Faced Wall Panels
4. _____

B. Related Requirements:

1. Section 05 5000 "Metal Fabrications" for steel supports and framing
2. Section 05 7300 "Decorative Metal Railings" for railings to receive hardwood handrail
3. Section 06 4113 "Wood-Veneer Faced Architectural Woodwork" for millwork fabrications including cabinetry, checker station, mailboxes, trash and recycling stations, and other millwork fabrications required to meet AWI standards
4. Section 08 4116 "Flush Wood Doors" for custom solid core wood veneer door to match wood veneer specified herewith.
5. Section 09 2216 "Non-Structural Metal Framing" for interior wall and ceiling finish framing.
6. Section 09 9123 "Interior Painting" for priming and backpriming of interior finish carpentry.

1.3 DEFINITIONS

- A. MDF: Medium-density fiberboard.
- B. MDO: Plywood with a medium-density overlay on the face.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors 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. Include chemical-treatment manufacturer's written instructions for finishing treated material.
 2. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
 3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced before shipment to Project site to levels specified.

- B. Sustainable Design Submittals:
1. 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.
 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 composite wood products, indicating that product contains no urea formaldehyde.
 5. Product Data: For installation adhesives, indicating VOC content.
- C. Samples for Initial Selection: For each type of product involving selection of colors, profiles, or textures.
- D. Samples for Verification:
1. For each species and cut of lumber and panel products with non-factory-applied finish, with 1/2 of exposed surface finished, **50 sq. in. (300 sq. cm)** for lumber and **8 by 10 inches (200 by 250 mm)** for panels.
 2. For each finish system and color of lumber and panel products with factory-applied finish, **50 sq. in. (300 sq. cm)** for lumber and **8 by 10 inches (200 by 250 mm)** for panels.
 3. For each fabric backer or scrim installed with wood grille panel assemblies
- E. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
1. Show details full size.
 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 3. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
 4. Include elevations showing panel sizes and direction pattern
 5. Include plans, elevations, sections, and mounting devices and details.
 6. Include details at joints and corners; and details at wall transitions and penetrations. Indicate panel edge materials.
 7. Wood grille ceilings:
 - a. include RCP and product details. Coordinate Wood Grille ceiling panels layout and installation of wood panels and suspension system components with other construction elements that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components, partition assemblies and all perimeter conditions.
 8. Flush Wood Paneling: Provide fully coordinated shop drawings with interior elevations, section details, and wood veneer matching for wall integrating flush wood wall panels with architectural woodwork door faces of recessed lockers.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's warranty.
- B. Qualification Data: For fabricator.
- C. Product Certificates: For the following:
1. Composite wood and agrifiber products.
 2. Adhesives.

- D. Coordination Drawings: Elevations 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. Electrical outlets, switches, and thermostats.
 - 2. Items penetrating or covered by wall panels, including the following:
 - a. Air outlets and inlets.
 - b. Speakers.
 - c. Alarms.
 - d. Sprinklers.
 - e. Access panels.
 - 3. Show operation of hinged and sliding components covered by or adjacent to wall panels.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.
- C. 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. Shop is a certified participant in AWI's Quality Certification Program.
- D. Installer Qualifications: Fabricator of products.
- E. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials, fabrication, and installation.
 - 1. Build mockup of typical flush wood panel wall area including wood trim edging as directed by Architect.
 - 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.
- F. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Protect materials from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.
- B. Deliver interior finish carpentry materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

1.8 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.
- C. Environmental Limitations for Interior Work: Do not deliver or install interior ornamental woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 25 and 55 percent during the remainder of the construction period.
- D. Field Measurements: Where ornamental woodwork is 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.
 - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
- E. Established Dimensions: Where ornamental woodwork is indicated to fit to other construction, establish dimensions for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.9 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that ornamental woodwork can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Low-Emitting Materials: Composite wood materials made without urea formaldehyde, and complying with Section 01 8116 "VOC Limits"
- B. Certified Wood: All interior wood and wood based carpentry shall be produced from wood certified as "FSC Pure" or "FSC Mixed NN%" where NN% is equal to or greater than 50%, according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and FSC STD-40-004, "FSC Standard for Chain of Custody Certification."
- C. Regional Materials: The following wood products shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.
- D. Composite Wood Products: Products shall be made without urea formaldehyde.
- E. Lumber: DOC PS 20 and the following grading rules:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association, "Standard Grading Rules for Northeastern Lumber."

2. NHLA: National Hardwood Lumber Association, "Rules for the Measurement and Inspection of Hardwood & Cypress."
 3. NLGA: National Lumber Grades Authority, "Standard Grading Rules for Canadian Lumber."
 4. SPIB: The Southern Pine Inspection Bureau, "Standard Grading Rules for Southern Pine Lumber."
 5. WCLIB: West Coast Lumber Inspection Bureau, Standard No. 17, "Grading Rules for West Coast Lumber."
 6. WWPA: Western Wood Products Association, "Western Lumber Grading Rules."
- F. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.
1. For exposed lumber, mark grade stamp on end or back of each piece.
- G. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.
- H. MDF: ANSI A208.2, Grade 130, made with binder containing no urea-formaldehyde resin.

2.2 FIRE-RETARDANT-TREATED MATERIALS

- A. General: For applications indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction, and comply with testing requirements; testing 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 according to ASTM E 84, 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. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent respectively.
- C. For exposed items indicated to receive a stained or natural finish, use organic resin chemical formulations that do not contain colorants, and provide materials that do not have marks from spacer sticks on exposed face.
- D. Do not use material that does not comply with requirements for untreated material or is warped or discolored.
- E. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.
 2. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.
- F. Application: Where indicated.

2.3 INTERIOR TRIM

- A. Hardwood Lumber Wall Base Trim for Transparent Finish:
1. Species and Grade:

- a. Cherry, Quarter Sawn
- b. Clear A Finish; NHLA.
- c. Grade: Premium.
2. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
3. Finger Jointing: Not allowed.
4. Gluing for Width: Not allowed.
5. Veneered Material: Not allowed.
6. Face Surface: Surfaced (smooth).
7. Matching: Selected for compatible grain and color.

B. Lumber Trim for Opaque Finish (Painted Finish):

1. Grade: Custom.
2. Any Closed Grain hardwood.
3. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
4. Finger Jointing: Not allowed.
5. Face Surface: Surfaced (smooth).

2.4 FLUSH WOOD PANELING

- A. Grade: Premium.
- B. Wood Species and Cut: Cherry, Quarter Sawn, Solid clear stain
- C. Size: As Indicated on drawings
- D. Panel-Matching Method: No matching is required between panels. Select and arrange panels for similarity of grain pattern and color between adjacent panels.
- E. Exposed Panel Edges: Inset solid-wood or wood-veneer matching faces.
- F. Assemble panels by gluing and concealed fastening.

2.5 STAIRS AND RAILINGS

- A. Wood Rails: Clear, straight-grained hardwood rails secured to recessed metal subrail.
 1. Species: Cherry.
 2. Finish: Penetrating oil.
 3. Staining: TBD.
 4. Profile: As indicated.
 5. Certified Wood: Wood products shall be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004.

B. Stair Treads:

2.6 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. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.
 - 1. Wood glue shall have a VOC content of 30 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Paneling Adhesive: Comply with paneling manufacturer's written recommendations for adhesives.
 - 1. Adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.
 - 1. Adhesive shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 FABRICATION

- A. Back out or kerf backs of the following members except those with ends exposed in finished work:
 - 1. Interior standing and running trim except shoe and crown molds.
 - 2. Wood-board paneling.
- B. Ease edges of lumber less than 1 inch (25 mm) in nominal thickness to 1/16-inch (1.5-mm) radius and edges of lumber 1 inch (25 mm) or more in nominal thickness to 1/8-inch (3-mm) radius.

2.8 SHOP FINISHING

- A. General: Finish paneling at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
- B. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing ornamental woodwork, as applicable to each unit of work.
 - 1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of ornamental woodwork. Apply two coats to end-grain surfaces.
- C. Transparent Finish:
 - 1. Grade: Same as item to be finished.
 - 2. Finish: System - 5, conversion varnish.
 - 3. Finish: System - 6, synthetic penetrating oil.
 - 4. Finish: System - 11, catalyzed polyurethane.
 - 5. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
 - 6. Staining: Match approved sample for color and sheen
 - 7. Filled Finish for Open-Grain Woods: After staining, apply wash-coat sealer and allow to dry. Apply paste wood filler and wipe off excess. Tint filler to match stained wood.
 - 8. For wood veneer finishes exposed to direct sunlight through glazing, include fabricators recommendations for finishing to protect wood from fading.
- D. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- 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 unless longer conditioning is recommended by manufacturer.

3.3 INSTALLATION, GENERAL

- A. Grade: Install interior finish carpentry to comply with same AWI standard grade as item to be installed.
- B. 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.
- C. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
 - 1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
 - 2. Install to tolerance of **1/8 inch in 96 inches (3 mm in 2438 mm)** for level and plumb. Install adjoining interior finish carpentry with **1/32-inch (0.8-mm)** maximum offset for flush installation and **1/16-inch (1.5-mm)** maximum offset for reveal installation.
 - 3. 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 STANDING AND RUNNING TRIM INSTALLATION

- A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than **24 inches (610 mm)** long, except where necessary. Stagger joints in adjacent and related standing and running trim. 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. Use scarf joints for end-to-end joints. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.
 - 1. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
 - 2. Install trim after gypsum-board joint finishing operations are completed.

3. Install without splitting; drill pilot holes before fastening where necessary to prevent splitting. Fasten to prevent movement or warping. Countersink fastener heads on exposed carpentry work and fill holes.

3.5 PANELING INSTALLATION

- A. Board Paneling: Install according to manufacturer's written instructions. Arrange in random-width pattern suggested by manufacturer unless boards or planks are of uniform width.
 1. Install in full lengths without end joints.
 2. Select and arrange boards on each wall to minimize noticeable variations in grain character and color between adjacent boards. Install with uniform tight joints between boards.
 3. Fasten paneling with trim screws, set below face and filled.
 4. Fasten paneling with paneling system manufacturer's concealed clips.
 5. Fasten paneling to gypsum wallboard with panel adhesive.

3.6 STAIR AND RAILING INSTALLATION

- A. Railings: Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts, and glue. Assemble railings at goosenecks, easements, and splices with rail bolts and glue.

3.7 ADJUSTING

- A. Replace interior finish carpentry that is damaged or does not comply with requirements. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

3.8 CLEANING

- A. Clean interior finish carpentry on exposed and semiexposed surfaces. Restore damaged or soiled areas and touch up factory-applied finishes, if any.

3.9 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

SECTION 06 4113

WOOD-VENEER-FACED ARCHITECTURAL CABINETS

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. Architectural wood cabinets.
 - 2. Shop finishing of architectural wood fabrications
- B. Related Requirements:
 - 1. Section 05 5000 "Metal Fabrications" for countertop supports and miscellaneous steel supports and trim
 - 2. Section 06 1053 "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets and concealed within other construction before cabinet installation.
 - 3. Section 11 3100 "Residential Appliances" for appliances installed in cabinetry at kitchens
 - 4. Section 12 3600 "Countertops" for countertop material installed with architectural cabinets
 - 5. Division 27 for ventilation requirements associated with AV equipment located within wood-veneer-faced credenza unit specified herewith.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product and finishing materials and processes.
 - 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- 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. [Chain-of-Custody Certificates](#): For certified wood products. Include statement of costs.
 - 4. [Product Data](#): For adhesives, indicating that product contains no urea formaldehyde.
 - 5. [Product Data](#): For composite wood products, indicating that product contains no urea formaldehyde.
- C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

1. Show details full size.
2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
3. Show locations and sizes of cutouts and holes for electrical switches and outlets and other items installed in architectural wood cabinets.
4. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.

D. Samples for Initial Selection:

1. Shop-applied transparent finishes.

E. Samples for Verification:

1. Lumber for transparent finish, not less than 5 inches (125 mm) wide by 12 inches (300 mm) long, for each species and cut, finished on one side and one edge.
2. Veneer leaves representative of and selected from flitches to be used for transparent-finished cabinets.
3. Corner pieces as follows:
 - a. Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, 18 inches (450 mm) high by 18 inches (450 mm) wide by 6 inches (150 mm) deep.
 - b. Miter joints for standing trim.
4. Exposed cabinet hardware and accessories, one unit for each type and finish.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of product.
- C. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.
- D. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

1.6 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. Shop is a certified participant in AWI's Quality Certification Program.
- B. Installer Qualifications: Fabricator of products.
- C. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver cabinets until painting and similar operations that could damage woodwork have been completed in installation areas. If cabinets must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 25 and 55 percent during the remainder of the construction period.
- B. Field Measurements: Where cabinets 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.
 - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed, and indicate measurements on Shop Drawings.
- C. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.9 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that wood-veneer-faced architectural cabinets can be supported and installed as indicated.
- B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Section 08 7100 "Door Hardware (Descriptive Specification)" to fabricator of architectural woodwork; coordinate Shop Drawings and fabrication with hardware requirements.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL CABINET FABRICATORS

- A. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of architectural wood cabinets with sequence-matched wood veneers and standing and running trim.

2.2 ARCHITECTURAL WOOD CABINETS, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of architectural wood cabinets indicated for construction, finishes, installation, and other requirements.
 - 1. Provide certificates from AWI certification program indicating that woodwork, including installation, complies with requirements of grades specified.
 - 2. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.

2.3 WOOD-VENEER-FACED MILLWORK FOR TRANSPARENT FINISH

- A. Grade: Premium

- B. Regional Materials: Wood cabinets for transparent finish shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.
- C. Certified Wood: Wood cabinets for transparent finish shall be produced from wood certified as "FSC Pure" or "FSC Mixed NN%" where NN% is equal to or greater than 50%, according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and FSC STD-40-004, "FSC Standard for Chain of Custody Certification."
- D. Type of Construction: Frameless.
- E. Cabinet and Door and Drawer Front Interface Style: Flush overlay with reveals.
- F. Wood for Exposed Surfaces:
 - 1. Species: Cherry
 - 2. Cut: Quarter Sawn
 - 3. Grain Direction: Vertically for doors and fixed panels, horizontally for drawer fronts.
 - 4. Matching of Veneer Leaves: Slip match.
 - 5. Veneer Matching within Panel Face: Center-balance match.
 - 6. Veneer Matching within Room: Provide cabinet veneers in each room or other space from a single flitch with doors, drawer fronts, and other surfaces matched in a sequenced set with continuous match where veneers are interrupted perpendicular to the grain.
- G. Semiexposed Surfaces: Provide surface materials indicated below:
 - 1. Surfaces Other Than Drawer Bodies: Same species and cut indicated for exposed surfaces.
 - 2. Drawer Subfronts, Backs, and Sides: Solid-hardwood lumber, same species indicated for exposed surfaces.
 - 3. Drawer Bottoms: Hardwood plywood.
- H. Dust Panels: **1/4-inch (6.4-mm)** plywood or tempered hardboard above compartments and drawers unless located directly under tops.
- I. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
 - 1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners.
- J. Provide opening below cabinet doors for air intake and grille at back of countertop for air/heat removal where cabinetry is indicated to store AV equipment with ventilation requirements. Protect wood veneer from heat exchange.

2.4 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
 - 1. Wood Moisture Content: 5 to 10 percent.
- B. Composite Wood and Agrifiber Products: 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: Provide MDF with minimum 80 percent recycled content

- C. Composite Wood Products: Products shall be made without urea formaldehyde.
1. MDF: ANSI A208.2, Grade 130.
 2. Softwood Plywood: DOC PS 1, medium-density overlay.
 3. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.

2.5 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials complying 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.
1. Use treated materials that comply with requirements of referenced woodworking standard. Do not use materials that are warped, discolored, or otherwise defective.
 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

2.6 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 08 7000 "Door Hardware."
- B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 135 degrees of opening, self-closing.
- C. Back-Mounted Pulls: BHMA A156.9, B02011.
- D. Pulls: Essential'z, 128 mm Pull, Satin Nickel
- E. Adjustable Shelf Rests: BHMA A156.9, B04013; **metal**.
- F. Drawer Slides: BHMA A156.9.
1. Grade 1 and Grade 2: Side mounted and extending under bottom edge of drawer.
 - a. Type: **Full** extension.
 - b. Material: [**Zinc-plated**] [**Epoxy-coated**] steel with polymer rollers.
 2. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-extension type; zinc-plated-steel ball-bearing slides.
 3. For drawers not more than **3 inches (75 mm)** high and not more than **24 inches (600 mm)** wide, provide Grade 1.
 4. For drawers more than **3 inches (75 mm)** high but not more than **6 inches (150 mm)** high and not more than **24 inches (600 mm)** wide, provide Grade 1HD-100.
 5. For drawers more than **6 inches (150 mm)** high or more than **24 inches (600 mm)** wide, provide Grade 1HD-200.
 6. For computer keyboard shelves, provide Grade 1HD-100.
 7. For trash bins not more than **20 inches (500 mm)** high and **16 inches (400 mm)** wide, provide Grade 1HD-200.
- G. Aluminum Slides for Sliding Glass Doors: BHMA A156.9, B07063.
- H. Door Locks: BHMA A156.11, E07121.

- I. Drawer Locks: BHMA A156.11, E07041.
- J. Door and Drawer Silencers: BHMA A156.16, L03011.
- K. Grommets for Cable Passage: **2-inch (51-mm)** OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
 - 1. Color: Stainless Steel
- L. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
 - 1. Dark, Oxidized, Satin Bronze, Oil Rubbed: BHMA 613 for bronze base; BHMA 640 for steel base; match Architect's sample.
 - 2. Bright Brass, Clear Coated: BHMA 605 for brass base; BHMA 632 for steel base.
 - 3. Bright Brass, Vacuum Coated: BHMA 723 for brass base; BHMA 729 for zinc-coated-steel base.
 - 4. Satin Brass, Blackened, Bright Relieved, Clear Coated: BHMA 610 for brass base; BHMA 636 for steel base.
 - 5. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
 - 6. Bright Chromium Plated: BHMA 625 for brass or bronze base; BHMA 651 for steel base.
 - 7. Satin Stainless Steel: BHMA 630.
- M. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.7 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish 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.
- C. Adhesives: Do not use adhesives that contain urea formaldehyde.
- D. Adhesives and Sealants: Comply with low-emitting requirements per Section 08 8113 "Sustainable Design Requirements"

2.8 FABRICATION

- A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- B. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
 - 1. Corners of Cabinets: **1/16 inch (1.5 mm)** unless otherwise indicated.
- C. 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. Notify Architect seven days in advance of the dates and times woodwork fabrication will be complete.
 2. 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.
- D. Shop-cut openings to maximum extent possible to receive hardware, appliances, 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.
- E. Core Materials shall be as follows:
1. Horizontal surfaces: All hardwood veneer core plywood
 2. Vertical Surfaces: All hardwood veneer core plywood or MDF 40 containing no urea formaldehyde at Contractor's option
 3. Doors: Provide solid bearing for hinges.

2.9 SHOP FINISHING

- A. General: Finish architectural wood cabinets at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
- B. General: Drawings indicate items that are required to be shop finished. Finish such items at fabrication shop as specified in this Section. Refer to Section 099123 "Interior Painting" for field finishing architectural woodwork not indicated to be shop finished.
- C. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural wood cabinets, as applicable to each unit of work.
1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of cabinets.
- D. Transparent Finish:
1. Grade: Same as item to be finished.
 2. Finish: System - 5, conversion varnish.
 3. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to cabinets made from closed-grain wood before staining and finishing.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition cabinets to average prevailing humidity conditions in installation areas.
- B. Before installing cabinets, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

- A. Grade: Install cabinets to comply with same grade as item to be installed.

- B. Assemble cabinets and complete fabrication at Project site to the extent that it was not completed in the shop.
- C. Install cabinets level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of **1/8 inch in 96 inches (3 mm in 2400 mm)**.
- D. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.
 - 1. For shop finished items use filler matching finish of items being installed.
- F. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 1. Install cabinets with no more than **1/8 inch in 96-inch (3 mm in 2400-mm)** sag, bow, or other variation from a straight line.
 - 2. Maintain veneer sequence matching of cabinets with transparent finish.
 - 3. Fasten wall cabinets through back, near top and bottom, and at ends not more than **16 inches (400 mm)** o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.
- G. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION

SECTION 07 1326

SELF-ADHERING SHEET WATERPROOFING

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. Modified bituminous sheet waterproofing.
 - 2. Blindsight sheet waterproofing.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

1.4 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. Sustainable Design Submittals:
 - 1. **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.
 - 2. **Product Data:** For recycled content, indicating postconsumer and preconsumer recycled content and cost.
- C. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
- D. Samples: For each exposed product and for each color and texture specified, including the following products:
 - 1. **8-by-8-inch (200-by-200-mm)** square of waterproofing and flashing sheet.

2. 4-by-4-inch (100-by-100-mm) square of drainage panel.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.
- C. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to set quality standards for installation.
 1. Build for each typical waterproofing installation including accessories to demonstrate surface preparation, crack and joint treatment, corner treatment, and protection.
 - a. Size: 100 sq. ft. (9.3 sq. m) in area.
 - b. Description: Each type of wall installation.
 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.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended 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.

1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard materials-only warranty in which 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.
 1. 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.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Source Limitations for Waterproofing System: Obtain waterproofing materials from single source from single manufacturer.

2.2 MODIFIED BITUMINOUS SHEET WATERPROOFING

- A. Modified Bituminous Sheet: 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. Basis of Design: Subject to compliance with requirements, provide Bituthene 4000 by W.R. Grace & Co, or a comparable product by one of the following:
 - a. [American Hydrotech, Inc.](#)
 - b. [CETCO, a Minerals Technologies company.](#)
 - c. [Henry Company.](#)
 - d. [Polyguard Products, Inc.](#)
 - e. [York Manufacturing, Inc.](#)
 2. Physical Properties:
 - a. Tensile Strength, Membrane: **250 psi (1.7 MPa)** minimum; ASTM D 412, Die C, modified.
 - b. Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
 - c. Low-Temperature Flexibility: Pass at **minus 20 deg F (minus 29 deg C)**; ASTM D 1970.
 - d. Crack Cycling: Unaffected after 100 cycles of **1/8-inch (3-mm)** movement; ASTM C 836.
 - e. Puncture Resistance: **40 lbf (180 N)** minimum; ASTM E 154.
 - f. Water Absorption: 0.2 percent weight-gain maximum after 48-hour immersion at **70 deg F (21 deg C)**; ASTM D 570.
 - g. Water Vapor Permeance: **0.05 perms (2.9 ng/Pa x s x sq. m)** maximum; ASTM E 96/E 96M, Water Method.
 - h. Hydrostatic-Head Resistance: **200 feet (60 m)** minimum; ASTM D 5385.
 3. Sheet Strips: Self-adhering, rubberized-asphalt strips of same material and thickness as sheet waterproofing.

2.3 BONDED HDPE OR POLYETHYLENE SHEET WATERPROOFING

- A. Products: Subject to compliance with requirements, provide one of the following:
1. [Vertical Applications:](#)
 - a. [GCP Applied Technologies Inc. \(formerly Grace Construction Products\); Preprufe 160R.](#)
 - b. [Polyguard Products, Inc.; Underseal Blindside Membrane.](#)
 2. [Horizontal Applications:](#)
 - a. [GCP Applied Technologies Inc. \(formerly Grace Construction Products\); Preprufe 300R.](#)
 - b. [Polyguard Products, Inc.; Underseal Underslab Membrane.](#)

- B. Bonded HDPE Sheet for Vertical Applications: Uniform, flexible, multilayered-composite sheet membrane consisting of either a HDPE film coated with a pressure-sensitive adhesive and protective release liner, total **32-mil (0.8-mm)** thickness, or an HDPE film coated with a modified asphalt layer and a nonwoven geotextile-fabric final layer, total **73-mil (1.9-mm)** thickness; with the following physical properties:
1. Tensile Strength, Film: **4000 psi (27.6 MPa)** minimum; ASTM D 412.
 2. Low-Temperature Flexibility: Pass at **minus 10 deg F (minus 23 deg C)**; ASTM D 1970.
 3. Peel Adhesion to Concrete: **5 lbf/in. (875 N/m)** minimum; ASTM D 903, modified.
 4. Lap Adhesion: **2.5 lbf/in. (440 N/m)** minimum; ASTM D 1876, modified.
 5. Hydrostatic-Head Resistance: **231 feet (70 m)**; ASTM D 5385, modified.
 6. Puncture Resistance: **100 lbf (445 N)** minimum; ASTM E 154.
 7. Water Vapor Permeance: **0.01 perms (0.6 ng/Pa x s x sq. m)** maximum; ASTM E 96/E 96M, Water Method.
 8. Water Absorption: 0.5 percent maximum; ASTM D 570.
- C. Bonded HDPE or Polyethylene Sheet for Horizontal Applications: Uniform, flexible, multilayered-composite sheet membrane consisting of either an HDPE film coated with pressure-sensitive adhesive and protective release liner, total **46-mil (1.2-mm)** thickness, or a cross-laminated film of low- and medium-density polyethylene, coated with a modified asphalt layer and a nonwoven geotextile-fabric final layer, total **95-mil (2.4-mm)** thickness; with the following physical properties:
1. Tensile Strength, Film: **2000 psi (13.8 MPa)** minimum; ASTM D 412.
 2. Low-Temperature Flexibility: Pass at **minus 10 deg F (minus 23 deg C)**; ASTM D 1970.
 3. Peel Adhesion to Concrete: **5 lbf/in. (875 N/m)** minimum; ASTM D 903, modified.
 4. Lap Adhesion: **2.5 lbf/in. (440 N/m)** minimum; ASTM D 1876, modified.
 5. Hydrostatic-Head Resistance: **231 feet (70 m)**; ASTM D 5385, modified.
 6. Puncture Resistance: **200 lbf (890 N)** minimum; ASTM E 154.
 7. Water Vapor Permeance: **0.01 perms (0.6 ng/Pa x s x sq. m)** maximum; ASTM E 96/E 96M, Water Method.
 8. Water Absorption: 0.5 percent maximum; ASTM D 570.
- D. Mastic, Adhesives, and Detail Tape: Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.

2.4 AUXILIARY MATERIALS

- A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
1. Furnish liquid-type auxiliary 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) thick, predrilled at 9-inch (229-mm) centers.
- G. Protection Course: Extruded-polystyrene board insulation, unfaced, ASTM C 578, Type X, 1/2 inch (13 mm) thick.

2.5 MOLDED-SHEET DRAINAGE PANELS

- A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of 9 to 21 gpm per ft. (112 to 261 L/min. per m).
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Hydrotech, Inc.
 - b. CETCO, a Minerals Technologies company.
 - c. Polyguard Products, Inc.

2.6 INSULATION

- A. Insulation, General: Comply with Section 072100 "Thermal Insulation."

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 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 according to ASTM D 4263.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE 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 and fill honeycomb, aggregate pockets, holes, and other voids.
- E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.
 - 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)**.
- F. 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.
- G. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.
 - 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.
- H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to ASTM D 6135.

3.3 MODIFIED BITUMINOUS SHEET-WATERPROOFING APPLICATION

- A. Install modified bituminous sheets according to waterproofing manufacturer's written instructions and recommendations in ASTM D 6135.
- 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. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.
- E. Seal edges of sheet-waterproofing terminations with mastic.
- F. Install sheet-waterproofing and auxiliary materials to tie into adjacent waterproofing.
- G. 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.

- H. Immediately install protection course with butted joints over waterproofing membrane.
 - 1. Board insulation may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer and installed immediately.

3.4 BONDED HDPE OR POLYETHYLENE SHEET-WATERPROOFING APPLICATION

- A. Install blindside sheet waterproofing according to manufacturer's written instructions.
- B. Place and secure molded-sheet drainage panels over substrate. Lap edges and ends of geotextile to maintain continuity.
- C. Vertical Applications: Install sheet with HDPE 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 detailing tape.
- D. Horizontal Applications: Install sheet with HDPE or polyethylene 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.
- E. Corners: Seal lapped terminations and cut edges of sheet waterproofing at inside and outside corners with detail tape.
- F. Seal penetrations through sheet waterproofing to provide watertight seal with detail tape patches or wraps and a liquid-membrane troweling.
- G. Install sheet-waterproofing and auxiliary materials to produce a continuous watertight tie into adjacent waterproofing.
- H. 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 MOLDED-SHEET DRAINAGE-PANEL INSTALLATION

- A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesives or other methods that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

3.6 INSULATION INSTALLATION

- A. Install one or more layers of board insulation to achieve required thickness over waterproofed surfaces. Cut and fit to within **3/4 inch (19 mm)** of projections and penetrations.

- B. On vertical surfaces, set insulation units in adhesive or tape applied according to manufacturer's written instructions.
- C. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests.
- B. Manufacturer's Field Service: Engage a site 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.
- D. Engage an independent testing agency to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.
- E. Prepare test and inspection reports.

3.8 PROTECTION, REPAIR, AND CLEANING

- A. Protect waterproofing from damage and wear during remainder of construction period.
- B. Protect installed board insulation from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- 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 by manufacturer of affected construction.

END OF SECTION

SECTION 07 2100
THERMAL INSULATION

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. Polyisocyanurate Board Insulation
 - 2. Nailable Roof Insulation
 - 3. Extruded polystyrene foam-plastic board.
 - 4. Glass-fiber blanket.
 - 5. Mineral-wool blanket.
 - 6. Mineral-wool board.
 - 7. Spray insulation
- B. Related Sections:
 - 1. Section 075216 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing", for insulation specified as part of roofing construction.
 - 2. Section 07 3113 - Asphalt Shingles

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
- B. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.6 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 before installation time.
 - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 POLYISOCYANURATE BOARD INSULATION

- A. Foil-Faced, Polyisocyanurate Board Insulation: ASTM C1289 Type 1, Class 1 or Class 2 with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Atlas Roofing Corporation
 - b. Dow Chemical Company (The)
 - c. Rmax, Inc
 - 2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
 - 3. Location: Exterior Wall Cavity
- B. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates

2.2 NAILABLE POLYISOCYANURATE ROOF INSULATION

- A. Nailable Polyisocyanurate Board Insulation: Closed-cell polyisocyanurate (polyiso) insulation board bonded to min. 7/16" APA/TECO rated OSB or min. 19/32" CDX plywood on the top face. Manufactured in accordance with ASTM C1289, Type V2 with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Atlas Roofing Corporation
 - b. Dow Chemical Company (The)

- c. **Rmax, Inc**
- 2. Location: Shingle roofs

- B. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates

2.3 FOAM-PLASTIC BOARD INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
 - 1. Basis of Design: Subject to compliance with requirements, provide DOW Styrofoam or a comparable product by one of the following:
 - a. **Kingspan**
 - b. **Owens Corning.**
 - 2. Type VI, **40 psi (276 kPa)**.
 - 3. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
- B. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

2.4 GLASS-FIBER BLANKET INSULATION

- A. Products: Subject to compliance with requirements, provide one of the following Products:
 - 1. Knauf EcoBatt
 - 2. Owens Corning Unfaced EcoTouch PINK
 - 3. Manufacturers not listed but who do offer products that comply with the requirements of this Section will be considered as substitute manufacturers, subject to the conditions specified in Division 1 Section Product Substitution Procedures.
- B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- C. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
 - 1. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
- D. Sustainability Requirements: Provide glass-fiber blanket insulation as follows:
 - 1. Free of Formaldehyde: Insulation manufactured with 100 percent acrylic binders and no formaldehyde.
 - 2. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.
 - 3. 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."

2.5 SPRAY INSULATION

- A. Open-Cell Polyurethane Foam Insulation: Spray-applied polyurethane foam using water as a blowing agent, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Icynene Inc.
 - b. BaySystems NorthAmerica, LLC.
 - c. Demilec (USA) LLC.
 - d. Gaco Western Inc.
 - e. SWD Urethane Company.
 2. Minimum density of 0.4 lb/cu. ft. (6.4 kg/cu. m), thermal resistivity of 3.4 deg F x h x sq. ft./Btu x in. at 75 deg F (24 K x m/W at 24 deg C).

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.
- B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
1. Angle: Formed from 0.030-inch- (0.762-mm-) thick, perforated, galvanized carbon-steel sheet with each leg 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.
- C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) square or in diameter.
- D. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 2 inches (50 mm) between face of insulation and substrate to which anchor is attached.
- E. 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 C 764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E 84.
- 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.

1. Adhesives shall have a VOC content of 70 g/L or less.
 2. Adhesive shall 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. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide ventilation between insulated attic spaces and vented eaves.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- 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. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

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 **48 inches (1220 mm)** below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
1. If not otherwise indicated, extend insulation a minimum of **48 inches (1220 mm)** in from exterior walls.

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. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.
 2. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings between concrete substrate and insulation.
 3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.
 4. 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 INSULATION FOR FRAMED CONSTRUCTION

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. 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. Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
 5. 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.
 6. For wood-framed construction, install blankets according to ASTM C 1320 and as follows:
 - a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.
- C. Seal joints of faced fiber insulation with joint closure tape.
- D. Spray-Applied Insulation: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.
- E. 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)**.

3.6 INSTALLATION OF INSULATION IN CEILINGS FOR SOUND ATTENUATION

- A. Where glass-fiber blankets are indicated for sound attenuation above ceilings, install blanket insulation over entire ceiling area in thicknesses indicated. Extend insulation **48 inches (1219 mm)** up either side of partitions.

3.7 INSTALLATION OF INSULATION FOR CONCRETE SUBSTRATES

- A. 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. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
 2. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
 3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
 4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

3.8 INSTALLATION OF INSULATION FOR ROOF SUBSTRATES

- A. Install insulation to substrates complying with manufacturer's written instructions. Bond insulation boards to substrate with adhesive per manufacturer's written recommendations.

3.9 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. 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

SECTION 07 2726

FLUID-APPLIED MEMBRANE AIR BARRIERS

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. Vapor-permeable, fluid-applied air barriers.
- B. Related Requirements:
 - 1. Section 061600 "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.

1.3 DEFINITIONS

- A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.
- B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
- C. Air-Barrier Assembly: The collection of air-barrier materials and accessory materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. 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.
- B. LEED Submittals:
 - 1. **Product Data:** For coatings, indicating VOC content.
 - 2. Product Data for EQ Credit: For air-barrier products, documentation including printed statement of VOC content.
- C. 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.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer. Include list of ABAA-certified installers and supervisors employed by Installer, who work on Project.
- 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.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
 1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.
- ~~B.~~ Mockups: Furnish air barrier for installation in Integrated Exterior Mockup, as Specified in Division 4 section

1.8 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.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended 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.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard materials-only warranty in which manufacturer agrees to furnish replacement air barrier material for air barrier that does not comply with requirements or that fails to remain airtight within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.
 2. Installer's Special Warranty: Form signed by Installer, covering Work of this Section, for warranty period of two years

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.
- B. VOC Content: 100 g/L or less.
- C. Low-Emitting Materials: Products shall 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."

2.2 PERFORMANCE REQUIREMENTS

- A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction shall 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 shall 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 according to ASTM E 283, ASTM E 783 or ASTM E 2357.

2.3 AIR BARRIERS, VAPOR PERMEABLE

- A. Fluid-Applied, Vapor-Permeable Membrane Air Barrier: synthetic polymer membrane.
 - 1. Synthetic Polymer Membrane:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) DuPont Building Innovations: E. I. du Pont de Nemours and Company. Tyvek Fluid Applied
 - 2) Henry Company, Sealants Division. Air-Bloc 31 or Air-Bloc 33.
 - 3) PROSOCO, Inc. Cat 5
 - 2. Physical and Performance Properties:
 - a. 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 E 2178.
 - b. Vapor Permeance: Minimum **10 perms (580 ng/Pa x s x sq. m)**; ASTM E 96/E 96M.
 - c. Ultimate Elongation: Minimum 200 percent; ASTM D 412, Die C.
 - d. Adhesion to Substrate: Minimum **30 lbf/sq. in. (207 kPa)** when tested according to ASTM D 4541.
 - e. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
 - f. UV Resistance: Can be exposed to sunlight for 90 days according to manufacturer's written instructions.

2.4 ACCESSORY MATERIALS

- A. Requirement: 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 A 240/A 240M, Type 304, **0.0250 inch (0.64 mm)** thick, and Series 300 stainless-steel fasteners.
- D. Preformed Silicone-Sealant 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.
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 123 Silicone Seal.
 - b. GE Construction Sealants; Momentive Performance Materials Inc US11000 UltraSpan.
 - c. Pecora Corporation; Sil-Span.
 - d. Tremco Incorporated, an RPM company; Spectrem Simple Seal.
- E. Joint Sealant: ASTM C 920, single-component, neutral-curing silicone; Class 100/50 (low modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Section 079200 "Joint Sealants."
- F. Termination Mastic: Air-barrier manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.
- G. Engineered Transition Assemblies
 - 1. Air Barrier Perimeter Seal to Windows, Doors, Curtain wall and Storefront Systems: Provide Proglaze Engineered Transition Assembly (ETA), manufactured by Tremco, Inc and as detailed in the following sections:
 - a. 08 4113 – Aluminum Framed Entrances and Storefronts
 - b. 08 4413 – Aluminum Framed Curtainwalls
 - c. 08 5113 – Aluminum Windows

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 concrete has cured and aged for minimum time period recommended by air-barrier manufacturer.
 - 3. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 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, and seal substrate according to manufacturer's written instructions. 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 membrane.
- 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 expansion joints and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement according to manufacturer's written instructions and details.

3.3 JOINT TREATMENT

- A. Concrete and Masonry: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 1193 and air-barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.
 - 1. Prime substrate and apply a single thickness of air-barrier manufacturer's recommended preparation coat extending a minimum of **3 inches (75 mm)** along each side of joints and cracks. Apply a double thickness of fluid air-barrier material and embed a joint reinforcing strip in preparation coat.
- B. Gypsum Sheathing: Fill joints greater than **1/4 inch (6 mm)** with sealant according to ASTM C 1193 and air-barrier manufacturer's written instructions. Apply first layer of fluid air-barrier material at joints. Tape joints with joint reinforcing strip after first layer is dry. Apply a second layer of fluid air-barrier material over joint reinforcing strip.

3.4 ACCESSORIES INSTALLATION

- A. Install accessory materials according to 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 preformed silicone extrusion 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.

3.5 FLUID AIR-BARRIER MEMBRANE INSTALLATION

- A. General: Apply fluid air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier according to air-barrier manufacturer's written instructions. Apply fluid air-barrier material within manufacturer's recommended application temperature ranges.
 1. Apply primer to substrates at required rate and allow it to dry.
 2. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
 3. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.

- B. Membrane Air Barriers: Apply a continuous unbroken air-barrier membrane to substrates according to the following thickness. Apply air-barrier membrane in full contact around protrusions such as masonry ties.
 - 1. Vapor-Permeable, 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. Apply strip and transition strip a minimum of **1 inch (25 mm)** onto cured air-barrier material or strip and transition strip over cured air-barrier material overlapping **3 inches (75 mm)** onto each surface according to air-barrier manufacturer's written instructions.
- D. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.
- E. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.6 FIELD QUALITY CONTROL

- A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. 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.
- D. Air barriers will be considered defective if they do not pass tests and inspections.
 - 1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
 - 2. Remove and replace deficient air-barrier components for retesting as specified above.
- E. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

3.7 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
 - 1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. If exposed to these conditions for more than 60 days, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed membrane according to 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 by manufacturer of affected construction.
- C. Remove masking materials after installation.

END OF SECTION

SECTION 07 3113
ASPHALT SHINGLES

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. Asphalt shingles.
2. Underlayment.
3. Ridge vents.
4. Metal flashing and trim.

B. Related Requirements:

1. Section 05 1200 "Structural Steel Framing"
2. Section 05 2110 "Composite Steel Joist"
3. Section 05 4000 "Cold-Formed-Metal Framing"
4. Section 06 1053 "Miscellaneous Rough Carpentry" for sleepers and blocking installed over metal deck at steep slope roof.
5. Section 06 1600 "Sheathing" for exterior sheathing installed at steep slope roofs, and at exterior wall under Fiber-Cement Siding
6. Section 07 2100 – "Thermal Insulation" for nailable roof insulation
7. Section 07 2713 "Modified Bituminous Sheet Air Barriers" for air barrier applied over wall and roof sheathing.
8. Section 07 5423 "Thermoplastic Polyolefin (TPO) Roofing" for low slope roofing membrane system
9. Section 07 6200 "Sheet Metal Flashing and Trim"
10. Section 07 7200 "Roof Accessories" for accessories not specified herewith.

1.3 DEFINITION

- A. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Samples: For each exposed product and for each color and texture specified.

1. Asphalt Shingles: Full size.
2. Ridge and Hip Cap Shingles: Full size.
3. Ridge Vent: 12-inch- (300-mm-) long Sample.

4. Exposed Valley Lining: 12 inches (300 mm) square.

C. Samples for Initial Selection: For each type of asphalt shingle indicated.

1. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For the following products, of sizes indicated:

1. Asphalt Shingles: Full size.

2. Ridge and Hip Cap Shingles: Full size.

3. Ridge Vent: 12-inch- (300-mm-) long Sample.

4. Exposed Valley Lining: 12 inches (300 mm) square.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each type of asphalt shingle and underlayment product indicated, for tests performed by a qualified testing agency.

C. Evaluation Reports: For high-temperature, self-adhering sheet underlayment, from ICC-ES or other testing and inspecting agency acceptable to authorities having jurisdiction, indicating that product is suitable for intended use under applicable building codes.

D. Sample Warranty: For manufacturer's warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For asphalt shingles to include in maintenance manuals.

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. Asphalt Shingles: 100 sq. ft. (9.3 sq. m) of each type, in unbroken bundles.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Store roofing materials in a dry, well-ventilated location protected from weather, sunlight, and moisture according to manufacturer's written instructions.

B. Store underlayment rolls on end on pallets or other raised surfaces. Do not double stack rolls.

C. Protect unused roofing materials from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

D. Handle, store, and place roofing materials in a manner to prevent damage to roof deck or structural supporting members.

1.11 FIELD CONDITIONS

- A. Environmental Limitations: Install self-adhering sheet underlayment within the range of ambient and substrate temperatures recommended in writing by manufacturer.

1.12 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace asphalt shingles that fail within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Manufacturing defects.
 2. Material Warranty Period: 30 years from date of Substantial Completion
 3. Wind-Speed Warranty Period: Asphalt shingles will resist blow-off or damage caused by wind speeds of up to **80 mph (36 m/s)** for 10 years from date of Substantial Completion.
 4. Algae-Resistance Warranty Period: Asphalt shingles will not discolor for 10 years from date of Substantial Completion.
 5. Workmanship Warranty Period: 20 years from date of Substantial Completion.
- B. Roofing Installer's Warranty: On warranty form at end of this Section, signed by Installer, in which Installer agrees to repair or replace components of asphalt-shingle roofing 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 PERFORMANCE REQUIREMENTS

- A. Exterior Fire-Test Exposure: Provide asphalt shingles and related roofing materials identical to those of assemblies tested for Class A fire resistance according to ASTM E 108 or UL 790 by Underwriters Laboratories or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

2.2 GLASS-FIBER-REINFORCED ASPHALT SHINGLES – MATCH BUILDING A

- A. Laminated-Strip, Asphalt Shingles: ASTM D 3462/D 3462M, laminated, multi-ply overlay construction, glass-fiber reinforced, mineral-granule surfaced, and self-sealing.
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. [GAF Materials Corporation](#) – Timberline HD (Basis of Design)
 - b. [Atlas Roofing Corporation](#).
 - c. [CertainTeed Corporation](#)
 2. Butt Edge: Straight cut.
 3. Strip Size: Manufacturer's standard.
 4. Algae Resistance: Granules treated to resist algae discoloration.
 5. Color and Blends: Hickory Color (per BOD) to match campus standard
- B. Hip and Ridge Shingles: Manufacturer's standard units to match asphalt shingles.

2.3 UNDERLAYMENT MATERIALS

- A. Felt: ASTM D 226/D 226M, asphalt-saturated organic felts, nonperforated.
1. Type: Type II.

- B. Self-Adhering Sheet Underlayment, High Temperature: Minimum of **40-mil- (1.0-mm-)** thick; with slip-resisting, polymer-film-reinforced or glass-reinforced top surface laminated to layer of butyl or SBS-modified asphalt adhesive; with release backing; cold applied; and evaluated and documented to be suitable for use for intended purpose under applicable codes by a testing and inspecting agency acceptable to authorities having jurisdiction. Provide primer for adjoining concrete or masonry surfaces to receive underlayment.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. GAF Materials Corporation.
 - b. Grace Construction Products; W.R. Grace & Co. -- Conn.
 - c. Henry Company.
 2. Thermal Stability: Stable after testing at **240 deg F (116 deg C)** according to ASTM D 1970/D 1970M.
 3. Low-Temperature Flexibility: Passes after testing at minus **20 deg F (29 deg C)** according to ASTM D 1970/D 1970M.
- C. Granular-Surfaced Valley Lining: ASTM D 3909, mineral-granular-surfaced, glass-felt-based, asphalt roll roofing; **36 inches (914 mm)** wide.

2.4 RIDGE VENTS

- A. Rigid Ridge Vent: Manufacturer's standard, rigid section high-density polypropylene or other UV-stabilized plastic ridge vent with nonwoven geotextile filter strips; for use under ridge shingles.
1. Manufacturers Subject to compliance with requirements, provide products by the following:
 - a. GAF Materials Corporation – Cobra Ridge Vent 3 (Basis of Design)
 - b. Air Vent, Inc
 - c. Core-A-Vent
 - d. Owens Corning
 - e. Trimline Building Products
 2. Minimum Net Free Area: Manufacturer's Standard
 3. Width: Manufacturer's Standard
 4. Thickness: Manufacturer's Standard

2.5 ACCESSORIES

- A. Starter Strip: Manufacturer's standard self-sealing starter shingle strip
1. Basis of Design Product: Pro-Start by GAF
- B. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.
- C. Roofing Nails: ASTM F 1667; aluminum, stainless-steel, copper, or hot-dip galvanized-steel wire shingle nails, minimum **0.120-inch- (3-mm-)** diameter, sharp-pointed, with a minimum **3/8-inch- (9.5-mm-)** diameter flat head and of sufficient length to penetrate **3/4 inch (19 mm)** into solid wood decking or extend at least **1/8 inch (3 mm)** through OSB or plywood sheathing.
1. Shank: Barbed.
 2. Where nails are in contact with metal flashing, use nails made from same metal as flashing.
- D. Felt-Underlayment Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire with low-profile capped heads or disc caps, **1-inch (25-mm)** minimum diameter.

- E. Synthetic-Underlayment Fasteners: As recommended in writing by synthetic-underlayment manufacturer for application indicated.

2.6 METAL FLASHING AND TRIM

- A. General: Comply with requirements in Section 07 6200 "Sheet Metal Flashing and Trim."
 - 1. Sheet Metal: Stainless steel.

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 of the Work.
 - 1. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking or metal clips and that installation is within flatness tolerances.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored; and that provisions have been made for flashings and penetrations through asphalt shingles.
- 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 UNDERLAYMENT INSTALLATION

- A. General: Comply with underlayment manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.

3.3 METAL FLASHING INSTALLATION

- A. General: Install metal flashings and other sheet metal to comply with requirements in Section 07 6200 "Sheet Metal Flashing and Trim."
 - 1. Install metal flashings according to recommendations in ARMA's "Residential Asphalt Roofing Manual" and NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems."
- B. Apron Flashings: Extend lower flange over and beyond each side of downslope asphalt shingles and up the vertical surface.
- C. Step Flashings: Install with a headlap of **2 inches (50 mm)** and extend over the underlying asphalt shingle and up the vertical surface. Fasten to roof deck only.
- D. Cricket or Backer Flashings: Install against the roof-penetrating element extending concealed flange beneath upslope asphalt shingles and beyond each side.
- E. Rake Drip Edges: Install rake drip-edge flashings over underlayment and fasten to roof deck.
- F. Eave Drip Edges: Install eave drip-edge flashings below underlayment and fasten to roof sheathing.
- G. Pipe Flashings: Form flashing around pipe penetrations and asphalt shingles. Fasten and seal to asphalt shingles as recommended by manufacturer.

3.4 ASPHALT-SHINGLE INSTALLATION

- A. General: Install asphalt shingles according to manufacturer's written instructions, recommendations in ARMA's "Residential Asphalt Roofing Manual," and recommendations in NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems."
- B. Install starter strip along lowest roof edge, consisting of an asphalt-shingle strip with tabs removed at least **7 inches (175 mm)** wide with self-sealing strip face up at roof edge.
 - 1. Extend asphalt shingles **1/2 inch (13 mm)** over fasciae at eaves and rakes.
 - 2. Install starter strip along rake edge.
- C. Install first and remaining courses of asphalt shingles stair-stepping diagonally across roof deck with manufacturer's recommended offset pattern at succeeding courses, maintaining uniform exposure.
- D. Install first and remaining courses of asphalt shingles stair-stepping diagonally across roof deck with manufacturer's recommended offset pattern at succeeding courses, maintaining uniform exposure.
- E. Fasten asphalt-shingle strips with a minimum of six roofing nails located according to manufacturer's written instructions.
 - 1. Where roof slope exceeds 21:12, seal asphalt shingles with asphalt roofing cement spots.
 - 2. Where roof slope is less than 4:12, seal asphalt shingles with asphalt roofing cement spots.
 - 3. When ambient temperature during installation is below **50 deg F (10 deg C)**, seal asphalt shingles with asphalt roofing cement spots.
- A. Concealed Valley Lining: For closed-cut valleys. Comply with NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems." Install underlayment centered in valley and fastened to roof deck.
 - 1. Lap roof-deck underlayment over valley underlayment at least **6 inches (150 mm)**.
 - 2. Install a full-width sheet of synthetic underlayment centered in valley. Lap ends of strips at least **12 inches (300 mm)** in direction to shed water, and seal with asphalt roofing cement. Fasten to roof deck.
- B. Ridge Vents: Install continuous ridge vents over asphalt shingles according to manufacturer's written instructions. Fasten with roofing nails of sufficient length to penetrate sheathing.
- C. Hip and Ridge Shingles: Maintain same exposure of cap shingles as roofing shingle exposure. Lap cap shingles at ridges to shed water away from direction of prevailing winds. Fasten with roofing nails of sufficient length to penetrate sheathing.
 - 1. Fasten ridge cap asphalt shingles to cover ridge vent without obstructing airflow.

END OF SECTION

SECTION 07 4646
FIBER-CEMENT SIDING

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 fiber-cement siding and soffit finished to match Building A Approved Submittals
- B. Related Requirements:
 - 1. Section 04 4313 "Anchored Stone Masonry Veneer" for exterior wall stone cladding.
 - 2. Section 05 1200 "Structural Steel Framing"
 - 3. Section 05 2100 "Steel Joist"
 - 4. Section 05 4000 "Cold-Formed-Metal Framing"
 - 5. Section 06 1053 "Miscellaneous Rough Carpentry" for wood furring, grounds, nailers, and blocking.
 - 6. Section 06 1600 "Sheathing" for exterior sheathing installed under Fiber-Cement Siding
 - 7. Section 07 2726 "Fluid Applied Membrane Air Barriers" for air barrier applied over wall sheathing.

1.3 COORDINATION

- A. Coordinate siding installation with flashings and other adjoining construction to ensure proper sequencing.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples for Initial Selection: For fiber-cement siding and soffit including related accessories.
- C. Samples for Verification: For each type, color, texture, and pattern required.
 - 1. 24-inch- (600-mm-) wide-by-36-inch- (900-mm-) high Sample panel of siding assembled on plywood backing.
 - 2. 12-inch- (300-mm-) long-by-actual-width Sample of soffit.
 - 3. 12-inch- (300-mm-) long-by-actual-width Samples of trim and accessories.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of fiber-cement siding and soffit.

- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fiber-cement siding.
- C. Research/Evaluation Reports: For each type of fiber-cement siding required, from ICC-ES.
- D. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of product, including related accessories, to include in maintenance manuals.

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. Furnish full lengths of fiber-cement siding and soffit including related accessories, in a quantity equal to 2 percent of amount installed.

1.9 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for fabrication and installation.
 - 1. Build mockups for fiber-cement siding including accessories.
 - a. Size: 48 inches (1200 mm) long by 60 inches (1800 mm) high.
 - b. Include outside corner on one end of mockup and inside corner on other end.
 - 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.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with labels intact until time of use.
- B. Store materials on elevated platforms, under cover, and in a dry location.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including cracking and deforming.
 - b. Deterioration of materials beyond normal weathering.
 - 2. Warranty Period: 25 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain products, including related accessories, from single source from single manufacturer.

2.2 FIBER-CEMENT SIDING

- A. General: ASTM C 1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E 136; with a flame-spread index of 25 or less when tested according to ASTM E 84.
 - 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide **James Hardie Building Products, Inc.**; Hardiplank Siding or a comparable product by one of the following:
 - a. **CertainTeed Corporation.**
 - b. **GAF Materials Corporation.**
- B. Labeling: Provide fiber-cement siding that is tested and labeled according to ASTM C 1186 by a qualified testing agency acceptable to authorities having jurisdiction.
- C. Nominal Thickness: Not less than **5/16 inch (8 mm)**.
- D. Horizontal Pattern: Boards 12 ft. wide in plain style.
 - 1. Texture: Smooth.
- E. Panel Texture: **48-inch- (1200-mm-)** wide sheets with smooth texture.
- F. Factory Priming: Manufacturer's standard acrylic primer.
- G. Finish: Provide Manufacturer's full range

2.3 FIBER-CEMENT SOFFIT

- A. General: ASTM C 1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E 136; with a flame-spread index of 25 or less when tested according to ASTM E 84.
 - 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide **James Hardie Building Products, Inc.**; Hardiplank Siding or a comparable product by one of the following:
 - a. **CertainTeed Corporation.**
 - b. **GAF Materials Corporation.**
- B. Nominal Thickness: Not less than **5/16 inch (8 mm)**.
- C. Pattern: **24-inch- (600-mm-)** wide sheets with smooth texture.
- D. Ventilation: Provide perforated soffit.
- E. Factory Priming: Manufacturer's standard acrylic primer.
- F. Finish: Provide Manufacturer's full range

2.4 ACCESSORIES

- A. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.
 - 1. Provide accessories matching color and texture of adjacent siding unless otherwise indicated.

- B. Decorative Accessories: Provide the following fiber-cement decorative accessories as indicated:
 - 1. Corner posts.
 - 2. Door and window casings.
 - 3. Fasciae.
 - 4. Moldings and trim.
- C. Flashing: Provide stainless-steel flashing complying with Section 07 6200 "Sheet Metal Flashing and Trim" at window and door heads and where indicated.
- D. Fasteners:
 - 1. For fastening to substrate indicated, follow siding manufacturer's recommendations for fastener type.
 - 2. For fastening fiber cement, use stainless-steel fasteners.
- E. Insect Screening for Soffit Vents: Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh.
- F. Continuous Soffit Vents: Aluminum, hat-channel shape, with perforations; 2 inches (51 mm) wide and not less than 96 inches (2438 mm) long.
 - 1. Net-Free Area: 4 sq. in./linear ft. (280 sq. cm/m).
 - 2. Finish: As selected by Architect from Manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of fiber-cement siding and soffit and related accessories.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.

3.3 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
 - 1. Do not install damaged components.
 - 2. Install fasteners no more than 24 inches (600 mm) o.c.
- B. Install joint sealants as specified in Section 079200 "Joint Sealants" and to produce a weathertight installation.

3.4 ADJUSTING AND CLEANING

- A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.
- B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION

SECTION 07 6200

SHEET METAL FLASHING AND TRIM

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. Manufactured reglets with counterflashing.
2. Formed roof-drainage sheet metal fabrications.
3. Formed low-slope roof sheet metal fabrications.
4. Formed steep-slope roof sheet metal fabrications.
5. Formed wall sheet metal fabrications.
6. Formed equipment support flashing.
7. Formed overhead-piping safety pans.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 07 5423 "Thermoplastic Polyolefin (TPO) Roofing" for installation of sheet metal flashing and trim integral with roofing.
3. Section 07 4243 "Composite Wall Panels" for sheet metal flashing and trim integral with metal wall panels.
4. Section 07 4500 "Fiber Cement Wall Panels" for sheet metal flashing and trim integral with metal wall panels.
5. Section 07 4515 "HPL Wall and Soffit Panels" for sheet metal flashing and trim integral with metal wall panels.
6. Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
7. Section 079500 "Expansion Control" for manufactured sheet metal expansion-joint covers.

1.3 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
 - 3. Review requirements for insurance and certificates if applicable.
 - 4. Review sheet metal flashing observation and repair procedures after flashing installation.

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 for each manufactured product and accessory.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
- C. Shop Drawings: For sheet metal flashing and trim.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
 - 3. Include identification of material, thickness, weight, and finish for each item and location in Project.
 - 4. Include details for forming, including profiles, shapes, seams, and dimensions.
 - 5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
 - 6. Include details of termination points and assemblies.
 - 7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
 - 8. Include details of roof-penetration flashing.
 - 9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
 - 10. Include details of special conditions.
 - 11. Include details of connections to adjoining work.
 - 12. Detail formed flashing and trim at scale of not less than **1-1/2 inches per 12 inches (1:10)**.
- D. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.
- E. Samples for Verification: For each type of exposed finish.
 - 1. Sheet Metal Flashing: **12 inches (300 mm)** long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
 - 2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: **12 inches (300 mm)** long and in required profile. Include fasteners and other exposed accessories.
 - 3. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.
 - 4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Product Certificates: For each type of coping and roof edge flashing that is SPRI ES-1 tested.
- C. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- D. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
- 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. Provide Mock-up Panel as indicated on drawings and as detailed in Division 4 Unit Masonry.
 - a. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
 - b. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
 - 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.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.10 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows 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 according to ASTM D 2244.

- b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - 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: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. SPRI Wind Design Standard: Manufacture and install roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:
 1. Design Pressure: As indicated on Drawings.
- D. Recycled Content of Steel-Sheet Flashing and Trim: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent 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: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.
 1. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent 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.
 2. Color: Match Architect's sample.
 3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).

- C. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed; with smooth, flat surface.
 - 1. Finish: 2B (bright, cold rolled).

2.3 UNDERLAYMENT MATERIALS

- A. Felt: ASTM D 226/D 226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.
- B. Self-Adhering, High-Temperature Sheet: Minimum **30 mils (0.76 mm)** thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer.
 - 1. Basis of Design: Subject to compliance with requirements, provide [Grace Construction Products, a unit of W. R. Grace & Co.-Conn.](#); Ultra. or a comparable product by one of the following:
 - a. [Carlisle Residential, a division of Carlisle Construction Materials](#); WIP 300HT.
 - b. [Henry Company](#); Blueskin PE200 HT.
 - c. [Metal-Fab Manufacturing, LLC](#); MetShield.
 - d. [Owens Corning](#); WeatherLock Specialty Tile & Metal Underlayment.
 - 2. Thermal Stability: ASTM D 1970; stable after testing at **240 deg F (116 deg C)** or higher.
 - 3. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus **20 deg F (29 deg C)** or lower.
- C. Slip Sheet: Rosin-sized building paper, **3 lb/100 sq. ft. (0.16 kg/sq. m)** minimum.

2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
 - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 - 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 - 3. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
- C. Solder:
 - 1. For Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.

- D. Sealant Tape: Pressure-sensitive, 100 percent solids, 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.
- E. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- H. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.
- I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 MANUFACTURED SHEET METAL FLASHING AND TRIM

- A. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions and with interlocking counterflashing on exterior face, of same metal as reglet.
 - 1. Basis of Design: Subject to compliance with requirements, provide [products by Hohmann & Barnard, Inc.](#) or a comparable product by one of the following:
 - a. [Fry Reglet Corporation.](#)
 - b. [Heckmann Building Products, Inc.](#)
 - c. [Hickman Company, W. P.](#)
 - d. [Keystone Flashing Company, Inc.](#)
 - e. [National Sheet Metal Systems, Inc.](#)
 - 2. Material: Stainless steel, **0.019 inch (0.48 mm)** thick.
 - 3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
 - 4. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
 - 5. Concrete Type: 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.
 - 6. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
 - 7. Accessories:
 - a. 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 Drawings show reglet without metal counterflashing.
 - b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.
 - 8. Finish: Mill.

2.6 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 2. Obtain field measurements for accurate fit before shop fabrication.
 3. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of **1/4 inch in 20 feet (6 mm in 6 m)** on slope and location lines indicated on Drawings and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
1. Form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with butyl sealant concealed within joints.
 2. Use lapped expansion joints only where indicated on Drawings.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.
- G. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
- H. Do not use graphite pencils to mark metal surfaces.

2.7 ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Hanging Gutters: Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum **96-inch- (2400-mm-)** long sections. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard but with thickness not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters. Shop fabricate interior and exterior corners.
1. Gutter Profile: as indicated.
 2. Expansion Joints: Lap type.

3. Accessories: Wire-ball downspout strainer.
4. Gutters with Girth up to **15 Inches (380 mm)**: Fabricate from the following materials:
 - a. Aluminum: **0.032 inch (0.81 mm)** thick, painted.

- B. Downspouts: Fabricate round downspouts to dimensions indicated, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.
 1. Hanger Style: as indicated.
 2. Fabricate from the following materials:
 - a. Aluminum: **0.024 inch (0.61 mm)** thick, painted.

2.8 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following materials:
 1. Stainless Steel: **0.016 inch (0.40 mm)** thick.
- B. Valley Flashing: Fabricate from the following materials:
 1. Stainless Steel: **0.019 inch (0.48 mm)** thick.
- C. Drip Edges: Fabricate from the following materials:
 1. Stainless Steel: **0.016 inch (0.40 mm)** thick.
- D. Eave, Rake, Ridge, and Hip Flashing: Fabricate from the following materials:
 1. Stainless Steel: **0.016 inch (0.40 mm)** thick.
- E. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
 1. Stainless Steel: **0.019 inch (0.48 mm)** thick.
- F. Flashing Receivers: Fabricate from the following materials:
 1. Stainless Steel: **0.016 inch (0.40 mm)** thick.
- G. Roof-Penetration Flashing: Fabricate from the following materials:
 1. Stainless Steel: **0.019 inch (0.48 mm)** thick.

2.9 WALL SHEET METAL FABRICATIONS

- A. Through-Wall Flashing: Fabricate continuous flashings in minimum **96-inch- (2400-mm-)** long, but not exceeding **12-foot- (3.6-m-)** long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend **6 inches (150 mm)** beyond each side of wall openings; and form with **2-inch- (50-mm-)** high, end dams. Fabricate from the following materials:
 1. Stainless Steel: **0.016 inch (0.40 mm)** thick.
- B. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend **4 inches (100 mm)** beyond wall openings. Form head and sill flashing with **2-inch- (50-mm-)** high, end dams. Fabricate from the following materials:
 1. Stainless Steel: **0.016 inch (0.40 mm)** thick.
- C. Wall Expansion-Joint Cover: Fabricate from the following materials:
 1. Stainless Steel: **0.019 inch (0.48 mm)** thick.

2.10 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Equipment Support Flashing: Fabricate from the following materials:
 - 1. Stainless Steel: 0.019 inch (0.48 mm) thick.
- B. Overhead-Piping Safety Pans: Fabricate from the following materials:
 - 1. Stainless Steel: 0.025 inch (0.64 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
 - 1. Verify compliance with requirements for installation tolerances of substrates.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 - 3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

- A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).
- B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, according to manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.
- C. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Prime substrate if recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps and edges with roller. Cover underlayment within 14 days.
- D. Apply slip sheet, wrinkle free, over underlayment before installing sheet metal flashing and trim.

3.3 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 3. Space cleats not more than **12 inches (300 mm)** apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
 4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
 5. Torch cutting of sheet metal flashing and trim is not permitted.
 6. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
1. Coat concealed side of uncoated-aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of **10 feet (3 m)** with no joints within **24 inches (600 mm)** of corner or intersection.
1. Form expansion joints of intermeshing hooked flanges, not less than **1 inch (25 mm)** deep, filled with sealant concealed within joints.
 2. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than **1 inch (25 mm)** into sealant. Form joints to completely conceal sealant. 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. Do not install sealant-type joints at temperatures below **40 deg F (4 deg C)**.
 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets with solder to width of **1-1/2 inches (38 mm)**; however, reduce pre-tinning where pre-tinned surface would show in completed Work.
1. Do not solder metallic-coated steel and aluminum sheet.
 2. Do not use torches for soldering.
 3. Heat surfaces to receive solder, and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

4. Stainless-Steel Soldering: Tin edges of uncoated sheets, using solder for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

- H. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

3.4 ROOF-DRAINAGE SYSTEM INSTALLATION

- A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Hanging Gutters: Join sections with riveted and soldered joints or joints sealed with sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchor them in position. Provide end closures and seal watertight with sealant. Slope to downspouts.
1. Fasten gutter spacers to front and back of gutter.
 2. Anchor back of gutter that extends onto roof deck with cleats spaced not more than **24 inches (600 mm)** apart.
 3. Anchor gutter with straps spaced not more than **30 inches (760 mm)** apart to roof deck, unless otherwise indicated, and loosely lock to front gutter bead.
 4. Install gutter with expansion joints at locations indicated, but not exceeding, **50 feet (15.24 m)** apart. Install expansion-joint caps.
- C. Downspouts: Join sections with **1-1/2-inch (38-mm)** telescoping joints.
1. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately **60 inches (1500 mm)** o.c.
 2. Connect downspouts to underground drainage system.

3.5 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered **3-inch (75-mm)** centers.
- C. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of **4 inches (100 mm)** over base flashing. Install stainless-steel draw band and tighten.
- D. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing **4 inches (100 mm)** over base flashing. Lap counterflashing joints minimum of **4 inches (100 mm)**. Secure in waterproof manner by means of interlocking folded seam or blind rivets and sealant unless otherwise indicated.

- E. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric or butyl sealant and clamp flashing to pipes that penetrate roof.

3.6 WALL FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Through-Wall Flashing: Installation of through-wall flashing is specified in Section 04 4200 "Exterior Stone Cladding."
- C. Reglets: Installation of reglets is specified in Section 033000 "Cast-in-Place Concrete" and Section 042000 "Unit Masonry."
- D. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend **4 inches (100 mm)** beyond wall openings.

3.7 MISCELLANEOUS FLASHING INSTALLATION

- A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.
- B. Overhead-Piping Safety Pans: Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings. Pipe and install drain line to plumbing waste or drainage system.

3.8 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of **1/4 inch in 20 feet (6 mm in 6 m)** on slope and location lines indicated on Drawings and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.

3.9 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.
- C. Clean off excess sealants.
- D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.

- E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07 7253

SNOW GUARDS

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. Pad-type, flat-mounted snow guards.

1.3 ACTION SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for snow guards.
- B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.
 - 1. Include details of rail-type snow guards.
 - 2. Include calculation of number and location of snow guards based on snow load, roof slope, roof type, components, spacings, and finish.
- C. Samples: Full-size unit.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of snow guard, for tests performed by manufacturer and witnessed by a qualified testing agency.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- B. Structural Performance:
 - 1. Snow Loads: As indicated on Drawings.

2.2 PAD-TYPE SNOW GUARDS

- A. Flat-Mounted Metal Snow Guard Pads: Stop-type snow guards
 - 1. Basis-of-Design Product: Berger RT200C Cast Aluminum Snow Guard.
 - 2. Finish: Powder Coated Finish to Match Approved Asphalt Shingles Color Selection

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.
 - 1. Verify compatibility with and suitability of substrates including compatibility with existing finishes or primers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and prepare substrates for bonding snow guards.
- B. Prime substrates according to snow guard manufacturer's written instructions.

3.3 INSTALLATION

- A. Install snow guards according to manufacturer's written instructions. Space rows as recommended by manufacturer.
- B. Attachment for Standing-Seam Metal Roofing:
 - 1. Do not use fasteners that will penetrate metal roofing, or fastening methods that void metal roofing finish warranty.
 - 2. Seam-Mounted Metal Snow Guard Pads: Stainless-steel clamps attached to vertical ribs of standing-seam metal roof panels.

END OF SECTION

SECTION 07 8413

PENETRATION FIRESTOPPING

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. Penetrations in fire-resistance-rated walls.
 - 2. Penetrations in smoke barriers.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 REFERENCES

- A. The following publications govern the work of this Section and are hereby incorporated in the Contract Documents as if bound herein. The standards described apply generally unless specifically indicated otherwise in the text. They are identified below by their publishers and are referred to in the text by basic designation only.
 - 1. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
 - ASTM E 84B91a Surface Burning Characteristics of Building Materials
 - ASTM E 814B88 Fire Tests of Through-Penetration Fire Stops
 - ASTM C 1193B91 Guide for Use of Joint Sealants
 - 2. UNDERWRITERS LABORATORIES (UL)
 - UL-05B92 Fire Resistance Directory
 - UL 723B93 Test for Surface Burning Characteristics of Building Materials
 - UL 1479B83 Fire Tests of Through-Penetration Firestops
 - UL 2079 Tests for Fire Resistance of Building Joint Systems

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.7 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.8 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.

1.9 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 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 firestopping systems shall bear classification marking of a qualified testing agency.
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek Group in its "Directory of Listed Building Products."
 - 3) FM Global in its "Building Materials Approval Guide."

2.2 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 shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Fire Protection Products.
 - b. A/D Fire Protection Systems Inc.
 - c. Construction Solutions.
 - d. Grabber Construction Products.
 - e. Hilti, Inc.
 - f. HOLDRITE.
 - g. NUCO Inc.

- h. [Passive Fire Protection Partners.](#)
 - i. [RectorSeal.](#)
 - j. [Specified Technologies, Inc.](#)
 - k. [STC Architectural Products.](#)
 - l. [Tremco, Inc.](#)
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of **0.01-inch wg (2.49 Pa)**.
- 1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of **0.01-inch wg (2.49 Pa)**.
- 1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
 - 2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
- D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of **0.30-inch wg (74.7 Pa)**.
- 1. L-Rating: Not exceeding **5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m)** of penetration opening at 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 E 84.
- 1. **Sealant shall have a VOC** content of 250 g/L or less.
- 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.
- 2.3 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 sheets with aluminum foil on one side.
- 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: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. 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.

2.4 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

- 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 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.
- B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- C. Proceed with enclosing penetration 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 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

SECTION 07 9200

JOINT SEALANTS

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. Silicone joint sealants.
 2. Urethane joint sealants.
 3. Latex joint sealants.
 4. Preformed joint sealants.
 5. Acoustical joint sealants.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product.
- B. Samples for Initial Selection: Manufacturer's 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 kind 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:
 1. Joint-sealant location and designation.
 2. Manufacturer and product name.

3. Type of substrate material.
 4. Proposed test.
 5. Number of samples required.
- D. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.
- E. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- F. Field-Adhesion-Test Reports: For each sealant application tested.
- G. Sample Warranties: For special warranties.
- 1.6 QUALITY ASSURANCE
- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.
1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.
- C. Mockups: 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 PRECONSTRUCTION TESTING
- A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
1. Adhesion Testing: Use ASTM C 794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 2. Compatibility Testing: Use ASTM C 1087 to determine sealant compatibility when in contact with glazing and gasket materials.
 3. Stain Testing: Use ASTM C 1248 to determine stain potential of sealant when in contact with stone substrates.
 4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
 5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
 7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.
- B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.

2. Conduct field tests for each kind of sealant and joint substrate.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
 - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.8 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.

1.9 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 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:** Sealants and sealant primers shall comply with the following:
 - 1. Architectural sealants shall have a VOC content of 250 g/L or less.
 - 2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
 - 3. Sealants and sealant primers for porous substrates shall have a VOC content of 775 g/L or less.
- C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Dow Corning Corporation](#); 790.
 - b. [Pecora Corporation](#); 301 NS, 311 NS, 890, or 890FTS.
 - c. [Tremco Incorporated](#); Spectrem 1 or Spectrem 800.
- B. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Dow Corning Corporation](#); 795.
 - b. [Pecora Corporation](#); 864, 895 or 898.
 - c. [Tremco Incorporated](#); Spectrem 2 or Spectrem 3.
- C. Silicone, Acid Curing, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Bostik, Inc.](#); Chem-Calk 1200.
 - b. [Dow Corning Corporation](#); 999-A.
 - c. [Pecora Corporation](#); 860.
 - d. [Tremco Incorporated](#); Proglaze or Tremsil 200.

2.3 URETHANE JOINT SEALANTS

- A. Urethane, M, NS, 25, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 25, Use NT.
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [BASF Building Systems](#); Sonolastic NP 2.
 - b. [Bostik, Inc.](#); Chem-Calk 500.
 - c. [May National Associates, Inc.](#); Bondaflex PUR 2 NS.
 - d. [Pecora Corporation](#); Dynatred.
 - e. [Tremco Incorporated](#); Vulkem 227.

- B. Urethane, M, NS, 25, T, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 25, Uses T.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [BASF Building Systems](#); Sonolastic NP 2.
 - b. [May National Associates, Inc.](#); Bondaflex PUR 2 NS.
 - c. [Pecora Corporation](#); Dynatred.

2.4 LATEX JOINT SEALANTS

- A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [BASF Building Systems](#); Sonolac.
 - b. [Bostik, Inc.](#); Chem-Calk 600.
 - c. [Pecora Corporation](#); AC-20+.
 - d. [Tremco Incorporated](#); Tremflex 834.

2.5 PREFORMED JOINT SEALANTS

- A. Preformed, Foam Joint Seals: Manufacturer's standard joint seal manufactured from urethane or EVA (ethylene vinyl acetate) foam with minimum density of **10 lb/cu. ft. (160 kg/cu. m)** and impregnated with a nondrying, water-repellent agent. Factory produce in precompressed sizes in roll or stick form to fit joint widths based on design criteria indicated, with factory- or field-applied adhesive for bonding to substrates.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [EMSEAL Joint Systems, Ltd.](#); Emseal 25V.
 - b. [LymTal International, Inc.](#); Iso-Flex Hydroseal Iso-Flex Precom C Iso-Flex Precom H Iso-Flex Precom H-PS Iso-Flex Precom H-SL Iso-Flex Precom V.
 - c. [MM Systems Corporation](#); EIF EIS SIF.
 - d. [Sandell Manufacturing Co., Inc.](#); Polyseal Polyseal Type C.
 - e. [Schul International Company, Inc.](#); Color Econoseal HydroStop HydroStop 61CR Sealtite 50N Sealtite Standard Sealtite VP Seismic Sealtite Seismic Sealtite 61CR.
 - f. [Watson Bowman Acme Corporation](#); Wabo SeismicWeatherSeal.
 2. Design Criteria:
 - a. Nominal Joint Width: As indicated on Drawings.
 - b. Minimum Joint Width: As indicated on Drawings.
 - c. Maximum Joint Width: As indicated on Drawings.
 - d. Movement Capability: -25 percent/+25 percent.
 3. Joint Seal Color: As selected by Architect from full range of industry colors.

2.6 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C 834.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Franklin International](#).
 - b. [Hilti, Inc.](#)
 - c. [Pecora Corporation](#).
 - d. [Tremco Incorporated](#).
 2. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.

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 C 1330, Type C (closed-cell 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 C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind 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 per Figure 8A in ASTM C 1193 unless otherwise indicated.
 4. Provide flush joint profile at locations indicated on Drawings according to Figure 8B in ASTM C 1193.
 5. Provide recessed joint configuration of recess depth and at locations indicated on Drawings according to Figure 8C in ASTM C 1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.
- G. Installation of Preformed Silicone-Sealant System: Comply with the following requirements:
1. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
 2. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone-sealant system manufacturer's written instructions and covering a bonding area of not less than **3/8 inch (10 mm)**. Hold edge of sealant bead **1/4 inch (6 mm)** inside masking tape.
 3. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
 4. Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.
- H. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping. Do not pull or stretch material. Produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures, apply heat to sealant in compliance with sealant manufacturer's written instructions.

3.4 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 C 919, ASTM C 1193, and manufacturer's written recommendations 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.

3.5 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
1. Extent of Testing: Test completed and cured sealant joints as follows:
 - a. Perform 10 tests for the first **1000 feet (300 m)** of joint length for each kind of sealant and joint substrate.
 - b. Perform one test for each **1000 feet (300 m)** of joint length thereafter or one test per each floor per elevation.
 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

- a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 3. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.6 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.

3.7 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.

3.8 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior and interior joints in horizontal traffic surfaces.
1. Joint Locations:
 - a. Control and expansion joints in brick pavers.
 - b. Isolation and contraction joints in cast-in-place concrete slabs.
 - c. Joints between plant-precast architectural concrete paving units.
 - d. Joints in stone paving units, including steps.
 - e. Tile control and expansion joints.
 - f. Joints between different materials listed above.
 - g. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane M NS 25 T.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:
 - a. Construction joints in cast-in-place concrete.
 - b. Joints between plant-precast architectural concrete units.
 - c. Control and expansion joints in unit masonry.
 - d. Joints in dimension stone cladding.
 - e. Joints between metal panels.
 - f. Joints between different materials listed above.
 - g. Perimeter joints between materials listed above and frames of doors windows and louvers.
 - h. Control and expansion joints in ceilings and other overhead surfaces.
 - i. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone S NS 100/50 NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Tile control and expansion joints.
 - c. Vertical joints on exposed surfaces of unit masonry concrete walls and partitions.
 - d. Other joints as indicated on Drawings.
 2. Joint Sealant: Latex OP NF.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints where indicated.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone, acid curing, S, NS, 25, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Location:
 - a. Acoustical joints where indicated.
 - b. Other joints as indicated.
 2. Joint Sealant: Acoustical.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

END OF SECTION

SECTION 07 9500
EXPANSION 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. Exterior wall expansion control systems.
 - 2. Interior expansion control systems.
- B. Related Requirements:
 - 1. Section 07 9200 "Joint Sealants" for liquid-applied joint sealants and for elastomeric sealants without metal frames.

1.3 ACTION SUBMITTALS

- A. Product Data: Prepared by or under the supervision of the supplier. Include the following information in tabular form:
 - 1. Manufacturer and model number for each expansion control system.
 - 2. Expansion control system location cross-referenced to Drawings.
 - 3. Nominal joint width.
 - 4. Movement capability.
 - 5. Classification as thermal or seismic.
 - 6. Materials, colors, and finishes.
 - 7. Product options.
 - 8. Fire-resistance ratings.
- B. Shop Drawings: For each expansion control system specified. Include plans, elevations, sections, details, splices, blockout requirement, attachments to other work, and line diagrams showing entire route of each expansion control system. Where expansion control systems change planes, provide isometric or clearly detailed drawing depicting how components interconnect.
- C. Samples for Initial Selection: For each type of expansion control system indicated.
 - 1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.
- D. Samples for Verification: For each type of expansion control system indicated, full width by 6 inches (150 mm) long in size.
- E. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:
 - 1. Manufacturer and model number for each expansion joint cover assembly.
 - 2. Expansion joint cover assembly location cross-referenced to Drawings.
 - 3. Nominal, minimum, and maximum joint width.

4. Movement direction.
5. Depth of recess to accept floor finishes
6. Materials, colors, and finishes.
7. Product options.
8. Fire Barrier locations and required rating
9. Water Barrier locations

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each fire barrier provided as part of an expansion control system, for tests performed by a qualified testing agency.

1.5 QUALITY ASSURANCE

- A. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
 1. Build mockup of typical expansion joint cover assembly as shown on Drawings.
 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.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Manufacturers: Subject to compliance with requirements, provide products by manufacturers listed below, or approved equal:
 1. **Balco, Inc.**
 2. **Nystrom, Inc.**
 3. MM Systems Corp (Basis of Design)
- B. Source Limitations: Obtain expansion control systems from single source from single manufacturer.
- C. General: Provide expansion control systems of design, basic profile, materials, and operation indicated. Provide units with capability to accommodate variations in adjacent surfaces.
 1. Furnish units in longest practicable lengths to minimize field splicing. Install with hairline mitered corners where expansion control systems change direction or abut other materials.
 2. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion control systems.
- D. Coordination: Coordinate installation of exterior wall and soffit expansion control systems with roof expansion control systems to ensure that wall transitions are watertight. Roof expansion joint assemblies are specified elsewhere.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: Where indicated, provide expansion control systems with fire barriers identical to those of systems tested for fire resistance per UL 2079 or ASTM E 1966 by a testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Expansion Joint Design Criteria:
 - 1. Type of Movement: Thermal.
 - a. Nominal Joint Width: As indicated on Drawings.
 - 2. Type of Movement: Seismic.
 - a. Joint Movement: As indicated on Drawings.
 - 3. Provide Fire Barrier

2.3 INTERIOR EXPANSION CONTROL SYSTEMS

- A. Floor-to-Floor:
 - 1. Design Criteria: Basis of Design – MM No Bump Floor Cover Systems Series LASB-NBR (inlay flooring)/LASF-NB (metal cover no inlay flooring)
 - a. Nominal Joint Width: 2-inches
 - b. Movement Capability: -25 percent/+75 percent.
 - c. Type of Movement: Thermal.
 - d. Load Capacity:
 - 1) Uniform Load: 150 lb/sq. ft. (732 kg/sq. m).
 - 2) Concentrated Load: 2000 lb (907 kg).
 - 3) Maximum Deflection: 0.5 inch (13 mm).
 - 2. Type: Elastomeric seal, recessed.
 - a. Cover-Plate Design: Recessed as required to accept field-applied finish materials.
 - 1) Cover-Plate Recess Depth: As required to accommodate adjacent flooring.
 - b. Seal Material: Manufacturer's standard.
 - 1) Color: As selected by Architect from manufacturer's full range.
 - c. Inlay Flooring Option where indicated: MM Model LASB-NBR
 - d. Metal Cover No Inlay Flooring: LASF-NB
 - 1) Exposed Metal Cover Plate Locations:
 - a) Aluminum Finish: Clear anodic, Class I or Color anodic, Class I.
 - b) Color: As selected by Architect from full range of industry colors and color densities
- B. Floor-to-Wall:
 - 1. Design Criteria: Basis of Design – MM No Bump Floor Cover Systems Series LASBE-NBR (Inlay Flooring Option)
 - a. Nominal Joint Width: 2-inches
 - b. Movement Capability: -25 percent/+75 percent.
 - c. Type of Movement: Thermal.
 - 2. Type: Elastomeric seal, recessed.
 - a. Cover-Plate Design: Recessed as required to accept field-applied finish materials.
 - 1) Cover-Plate Recess Depth: As required to accommodate adjacent flooring.
 - b. Seal Material: Manufacturer's standard.
 - 1) Color: As selected by Architect from manufacturer's full range.
- C. Wall-to-Wall:
 - 1. Design Criteria: Basis of Design – MM Flushline Wall Systems Series FSW
 - a. Nominal Joint Width: 2-inches
 - b. Movement Capability: -25 percent/+75 percent.
 - c. Type of Movement: Thermal.

2. Type: Continuous elastomeric seal, recessed.
 - a. Design: Concealed frame at all regularly occupied spaces, mud in place unless otherwise indicated.
 - b. Color: As selected by Architect from manufacturer's full range.

D. Wall Corner:

1. Design Criteria: Basis of Design – MM Flushline Wall Systems Series
 - a. Nominal Joint Width: 2-inches
 - b. Movement Capability: -25 percent/+75 percent.
 - c. Type of Movement: Thermal.
2. Type: Continuous elastomeric seal, recessed.
 - a. Design: Concealed frame in all regularly occupied spaces, mud in place unless otherwise indicated.
 - b. Color: As selected by Architect from manufacturer's full range.

E. Ceiling-to-Ceiling:

1. Design Criteria: Basis of Design – MM Flexible Wall and Ceiling Systems Series VSW
 - a. Nominal Joint Width: 2-inches
 - b. Movement Capability: -25 percent/+75 percent.
 - c. Type of Movement: Thermal.
2. Type: Elastomeric seal.
 - a. Concealed frame/mount, mud in place unless otherwise indicated
 - b. Color: As selected by Architect from manufacturer's full range.

F. Wall-to-Ceiling:

1. Design Criteria: Basis of Design – MM Flexible Wall and Ceiling System Model VSGL
 - a. Nominal Joint Width: 2-inches
 - b. Movement Capability: -25 percent/+75 percent.
 - c. Type of Movement: Thermal.
2. Type: Continuous elastomeric seal, recessed.
 - a. Design: Concealed frame, mud in place unless otherwise indicated.
 - b. Color: As selected by Architect from manufacturer's full range.

2.4 EXTERIOR EXPANSION JOINT COVERS

A. Wall-to-Wall, Wall to corner, and Soffit to Soffit:

1. Basis-of-Design Product: Subject to compliance with requirements, provide MM Systems VSS 200-600 or a comparable product by one of the following:
 - a. Balbo, Inc.
 - b. Construction Specialties Inc.
 - c. Nystrom, Inc.
2. Design Criteria:
 - a. Nominal Joint Width: As indicated on Drawings.
 - b. Movement Capability: -25 percent/+75 percent.
 - c. Type of Movement: Thermal.
 - d. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than that of adjacent construction.
3. Type: Elastomeric seal.
 - a. Color: As indicated on Drawings or as selected by Owner from manufacturer's standard range.

B. Preformed Silicone Expansion Joints

1. Type: Provide watertight flexible, preformed silicone rubber expansion systems that meet the specified movement requirements for applications indicated
 - a. Seal Material:
 - 1) High performance engineered silicone seal that is a minimum of 0.50 inch thick and is factory cured and fused to a cellular polyester/polyurethane foam backer block creating a monolithic and binary sealing system. A field applied primer-less one-part silicone sealant is used to achieve a 3-sided bond to the expansion joint sidewalls on each side of the preformed silicone seal.
 - 2) Color: As selected by Architect from manufacturer's full range.

2.5 FIRE-BARRIER SYSTEMS

- A. Fire Barrier System for Wall and Floor Expansion Joints: Manufacturer's Standard
 1. Design Criteria:
 - a. Designed to provide the required fire endurance rating of 2 through 4 hours
 - b. Up to 48-inches fire resistance ratings
 - c. Accommodates dynamic movement without stress or degradation to its components
 - d. Minimizes passage of smoke
 2. Composition:
 - a. Flexible, high purity ceramic fiber blanket, stainless steel foil and a matrix of fire-resistant cloth as required to achieve fire and endurance rating
 3. Mounting: Secured directly to joint opening per manufacturer's recommendations

2.6 WATER-BARRIER SYSTEMS

- A. Provide Water Barrier: Manufacturer's Standard

2.7 MATERIALS

- A. Aluminum: **ASTM B 221 (ASTM B 221M)**, Alloy 6063-T5 for extrusions; **ASTM B 209 (ASTM B 209M)**, Alloy 6061-T6 for sheet and plate.
 1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.
- B. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.
- C. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.

2.8 ALUMINUM FINISHES

- A. Mill finish
- B. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
- C. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces where expansion control systems will be installed for installation tolerances and other conditions affecting performance of work.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to expansion control system manufacturer's written instructions.
- B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion control systems. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion control systems.
- C. Cast-In Frames: Coordinate and furnish frames to be cast into concrete.

3.3 INSTALLATION

- A. Comply with manufacturer's written instructions for storing, handling, and installing expansion control systems and materials unless more stringent requirements are indicated.
- B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion control systems.
 - 1. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
 - 2. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation. Notify Architect where discrepancies occur that will affect proper expansion control system installation and performance.
 - 3. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
 - 4. Repair or grout blockout as required for continuous frame support using nonmetallic, shrinkage-resistant grout.
 - 5. Install frames in continuous contact with adjacent surfaces.
 - a. Shimming is not permitted.
 - 6. Locate anchors at interval recommended by manufacturer, but not less than **3 inches (75 mm)** from each end and not more than **24 inches (600 mm)** o.c.
- C. Seals in Metal Frames: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.
 - 1. Provide in continuous lengths for straight sections.
 - 2. Seal transitions according to manufacturer's written instructions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
 - 3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.
- D. Compression Seals: Apply adhesive or lubricant adhesive as recommended by manufacturer to both frame interfaces before installing compression seals.
- E. Foam Seals: Install with adhesive recommended by manufacturer.
- F. Terminate exposed ends of expansion control systems with field- or factory-fabricated termination devices.

- G. Moisture Barrier: Provide at all exterior joints and where indicated on Drawings. Provide drainage fittings at a maximum of 50 feet (15.2 m) or where indicated on Drawings.

3.4 PROTECTION

- A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.
- B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion control systems. Reinstall cover plates or seals prior to Substantial Completion of the Work.

END OF SECTION

SECTION 08 1113

HOLLOW METAL DOORS AND FRAMES

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. Interior standard steel doors and frames.
 - 2. Exterior standard steel doors and frames.
- B. Related Requirements:
 - 1. Section 08 3463 "Detention Doors and Frames" for hollow-metal doors and frames for detention facilities.
 - 2. Section 08 7100 "Door Hardware" for door hardware for hollow-metal doors.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 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.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.6 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. For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
 - 2. For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of

extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

- 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. Samples for Initial Selection: For hollow-metal doors and frames with factory-applied color finishes.
- E. Samples for Verification:
1. For each type of exposed finish required, prepared on Samples of not less than **3 by 5 inches (75 by 127 mm)**.
 2. Fabrication: Prepare Samples approximately **12 by 12 inches (305 by 305 mm)** to demonstrate compliance with requirements for quality of materials and construction:
 - a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
 - b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.
- F. Schedule: Provide a schedule of hollow-metal work 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.

1.7 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal work 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 work 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. Basis of Design: Subject to compliance with requirements, provide products by Ceco Door; ASSA ABLOY or a comparable product by one of the following:
1. Curries Company; ASSA ABLOY.
 2. Fleming Door Products Ltd.; Assa Abloy Group Company.
 3. Steelcraft; an Ingersoll-Rand company.
- B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings and temperature-rise limits indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
- B. Fire-Rated, Borrowed-Light Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to 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 according to ASTM C 518.

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: SDI A250.8, Level 3.
1. Physical Performance: Level A according to SDI A250.4.
 2. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: **1-3/4 inches (44.5 mm).**
 - c. Face: Uncoated, cold-rolled steel sheet, minimum thickness of **0.053 inch (1.3 mm).**
 - d. Edge Construction: Model 2, Seamless.
 - e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
 - f. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.
 - g. Fire-Rated Core: Manufacturer's standard vertical steel stiffener core for fire-rated and temperature-rise-rated doors.
 3. Frames:
 - a. Materials: Uncoated, steel sheet, minimum thickness of **0.053 inch (1.3 mm).**
 - b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
 - c. Construction: Face welded unless otherwise indicated.

- 1) Slip on drywall at in place gypsum board partitions.
4. 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. Maximum-Duty Doors and Frames: SDI A250.8, Level 4.
 1. Physical Performance: Level A according to SDI A250.4.
 2. 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 A40 (ZF120) coating.
 - d. Edge Construction: Model 2, Seamless.
 - 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 where required for attachment of weather stripping 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: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.
 - 1) Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 2.1 deg F x h x sq. ft./Btu (0.370 K x sq. m/W) when tested according to ASTM C 1363.
 - i. Fire-Rated Core: Manufacturer's standard vertical steel stiffener with insulation core for fire-rated doors.
 3. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch (1.7 mm), with minimum A40 (ZF120) coating.
 - b. Construction: Face welded.
 4. Exposed Finish: Prime.

2.5 BORROWED LITES

- A. Fabricate of uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
- B. Construction: Full profile welded.
- 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. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (51 mm) wide by 10 inches (254 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.
 - 2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (1.0 mm) thick.
 - 3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
 - 4. 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).
 - 5. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Material: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M; hot-dip galvanized according to ASTM A 153/A 153M, Class B.

2.8 MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
- E. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- F. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

- G. 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.
- H. Grout: ASTM C 476, except with a maximum slump of **4 inches (102 mm)**, as measured according to ASTM C 143/C 143M.
- I. Mineral-Fiber Insulation: ASTM C 665, 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 E 136 for combustion characteristics.
- J. Glazing: Comply with requirements in Section 08 8000 "Glazing."
- K. Bituminous Coating: Cold-applied asphalt mastic, compounded for **15-mil (0.4-mm)** dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.9 FABRICATION

- A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Hollow-Metal Doors:
 - 1. Steel-Stiffened Door Cores: Provide minimum thickness **0.026 inch (0.66 mm)**, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than **6 inches (152 mm)** apart. Spot weld to face sheets no more than **5 inches (127 mm)** o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
 - 2. Fire Door Cores: As required to provide fire-protection and temperature-rise ratings indicated.
 - 3. Vertical Edges for Single-Acting Doors: Provide square edges.
 - 4. Top Edge Closures: Close top edges of doors with inverted closures, except provide flush closures at exterior doors of same material as face sheets.
 - 5. Bottom Edge Closures: Close bottom edges of doors with end closures or channels of same material as face sheets.
 - 6. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
 - 7. 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.
- C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Sidelight and Transom Bar 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 butt welding.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
 5. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than 16 inches (406 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c., to match coursing, and as follows:
 - 1) Two anchors per jamb up to 60 inches (1524 mm) high.
 - 2) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
 - 3) Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.
 - 4) Four anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high.
 - b. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches (1524 mm) high.
 - 2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
 - 3) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
 - 4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.
 - c. Compression Type: Not less than two anchors in each frame.
 - d. Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.
 6. 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.
 7. Terminated Stops: Terminate stops 6 inches (152 mm) above finish floor with a 45-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.
- D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.
- E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to 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 applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.
- F. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
 1. Provide stops and moldings flush with face of door, and with beveled 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 SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2.11 ACCESSORIES

- A. Provide louvers for interior doors, where indicated, which comply with SDI 111, with blades or baffles formed of **0.020-inch- (0.5-mm-)** thick, cold-rolled steel sheet set into **0.032-inch- (0.8-mm-)** thick steel frame.
 1. Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.
- B. Form corners of moldings with hairline joints. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
- C. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- D. Grout Guards: Formed from same material as frames, not less than **0.016 inch (0.4 mm)** thick.

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 of the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- 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 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.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.
- B. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.
1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - b. Install frames with removable stops located on secure side of opening.
 - c. Install door silencers in frames before grouting.
 - d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - e. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - f. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.
 2. Fire-Rated Openings: Install frames according to NFPA 80.
 3. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and 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. Metal-Stud Partitions: 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.
 6. Concrete Walls: Solidly fill space between frames and concrete with mineral-fiber insulation.
 7. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 8. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb 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 hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Steel Doors: Comply with SDI A250.8.
 - a. Between Door and Frame Jambs and Head: **1/8 inch (3.2 mm)** plus or minus **1/32 inch (0.8 mm)**.
 - b. Between Edges of Pairs of Doors: **1/8 inch (3.2 mm)** to **1/4 inch (6.3 mm)** plus or minus **1/32 inch (0.8 mm)**.
 - c. At Bottom of Door with no Threshold: **5/8 inch (15.8 mm)** plus or minus **1/32 inch (0.8 mm)**.

- d. At Bottom of Door with Threshold: **3/4 inch (19.1 mm)** plus or minus **1/32 inch (0.8 mm)**.
 - e. Between Door Face and Stop: **1/16 inch (1.6 mm)** to **1/8 inch (3.2 mm)** plus or minus **1/32 inch (0.8 mm)**.
 - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
 - 3. Smoke-Control Doors: Install doors and gaskets according to NFPA 105.
- D. Glazing: Comply with installation requirements in Section 08 8000 "Glazing" and with hollow-metal manufacturer's written instructions.
- 1. Secure stops 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.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow-metal work immediately after installation.
- C. 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.
- D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- E. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION

SECTION 08 1416
FLUSH WOOD DOORS

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. Solid-core doors and transom panels 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 08 8000 "Glazing" for glass view panels in flush wood doors.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of door. Include details of core and edge construction, louvers, and trim for openings. Include factory-finishing specifications.
- B. Sustainable Design Submittals:
1. [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.
 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 that product contains no urea formaldehyde.
 5. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 6. [Product Data](#): For composite wood products, indicating that product contains no urea formaldehyde.
- 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 Initial Selection: For factory-finished doors.
- E. Samples for Verification:
 - 1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches (200 by 250 mm), for each material and finish. For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.
 - 2. Corner sections of doors, approximately 8 by 10 inches (200 by 250 mm), with door faces and edges representing actual materials to be used.
 - a. Provide Samples for each species of veneer and solid lumber required.
 - b. Finish veneer-faced door Samples with same materials proposed for factory-finished doors.
 - 3. Louver blade and frame sections, 6 inches (150 mm) long, for each material and finish specified.
 - 4. Frames for light openings, 6 inches (150 mm) long, for each material, type, and finish required.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.
- B. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body and is a licensee of WI's Certified Compliance Program.
- B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.7 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 top and bottom rail with opening number used on Shop Drawings.

1.8 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 ambient temperature and humidity conditions at occupancy levels during remainder of construction period.
- B. 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 (16 and 32 deg C) and relative humidity between 25 and 55 percent during remainder of construction period.

1.9 WARRANTY

- 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 (6.4 mm)** in a **42-by-84-inch (1067-by-2134-mm)** section.
 - b. Telegraphing of core construction in face veneers exceeding **0.01 inch in a 3-inch (0.25 mm in a 76.2-mm)** 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 MANUFACTURERS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. [Algoma Hardwoods, Inc.](#)
 2. Columbia Forest Products
 3. [Graham Wood Doors; ASSA ABLOY Group company.](#)
 4. Masonite Architectural
- B. Source Limitations: Obtain flush wood doors from single manufacturer.

2.2 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with AWI's, AWMAC's, and WI's "Architectural Woodwork Standards and WDMA I.S.1-A, "Architectural Wood Flush Doors."
1. Provide WI Certified Compliance Labels indicating that doors comply with requirements of grades specified.
 2. 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.
- A. **Regional Materials:** Wood doors shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.
- B. **Certified Wood:** Wood doors shall be certified as "FSC Pure" according to FSC STD-01-00 and FSC STD-40-004.
- C. **Adhesives:** Do not use adhesives that contain urea formaldehyde.
- D. **Composite Wood Products:** Products shall be made without urea formaldehyde.
- E. Composite Wood Products: Products shall 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."
- F. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain urea formaldehyde.

- G. WDMA I.S.1-A Performance Grade:
 - 1. Heavy Duty unless otherwise indicated.
 - 2. Extra Heavy Duty: Public toilets, janitor's closets, assembly spaces, exits and where indicated.
 - 3. Standard Duty: Closets (not including janitor's closets) and private toilets and where indicated.

- H. 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. 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.
 - 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.

- I. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.

- J. Structural-Composite-Lumber-Core Doors:
 - 1. Structural Composite Lumber: WDMA I.S.10.
 - a. Screw Withdrawal, Face: 700 lbf (3100 N).
 - b. Screw Withdrawal, Edge: 400 lbf (1780 N).

2.3 VENEER-FACED DOORS FOR TRANSPARENT FINISH

- A. Interior Solid-Core Doors:
 - 1. Grade: Premium, with Grade AA faces.
 - 2. Species: Cherry
 - 3. Cut: Quarter Sawn.
 - 4. Match between Veneer Leaves: Slip match.
 - 5. Assembly of Veneer Leaves on Door Faces: Balance match.
 - 6. Special Matching:
 - a. Pair and set match.
 - b. Room Match: Door faces of compatible color and grain within each room.
 - 7. Core: Either glued wood stave or structural composite lumber.
 - 8. Construction: Five plies, bonded.
 - 9. WDMA I.S.1-A Performance Grade: As indicated

2.4 LIGHT FRAMES AND LOUVERS

- 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: Manufacturer's standard shape.
 - 3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.

- B. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.
 - 1. Wood Species: Same species as door faces.
- C. Metal Louvers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Louvers, Inc.
 - b. Anemostat; a Mestek company.
 - c. L & L Louvers, Inc.
 - d. Louvers & Dampers, Inc.; a division of Mestek, Inc.
 - e. McGill Architectural Products.
 - 2. Metal and Finish: Extruded aluminum with Class II, clear anodic finish, AA-M12C22A31.

2.5 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. Transom and Side Panels: Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
 - 1. Fabricate door and transom panels with full-width, solid-lumber, rabbeted, meeting rails. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.
- D. 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 08 8000 "Glazing."
 - 3. Louvers: Factory install louvers in prepared openings.

2.6 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 top and bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors that are indicated to receive transparent finish.
- C. Transparent Finish:

1. Grade: Premium.
2. Finish: WDMA TR-4 conversion varnish or WDMA TR-6 catalyzed polyurethane.
3. Staining: TBD.
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 08 7100 "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 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

SECTION 08 1433

STILE AND RAIL WOOD DOORS

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. Exterior stile and rail wood doors.
 2. Finishing stile and rail wood doors

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include details of construction and glazing.
 2. Include factory-finishing specifications.
- B. Sustainable Design Submittals:
1. **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.
 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 that product contains no urea formaldehyde.
 5. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 6. **Product Data:** For composite wood products, indicating that product contains no urea formaldehyde.
- C. Shop Drawings: For stile and rail wood doors. Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data, including those for stiles, rails, panels, and moldings (sticking); and other pertinent data, including the following:
1. Dimensions of doors for factory fitting.
 2. Locations and dimensions of mortises and holes for hardware.
 3. Undercuts.
 4. Requirements for veneer matching.
 5. Doors to be factory finished and finish requirements.
 6. Fire-protection ratings for fire-rated doors.
- D. Samples for Initial Selection: For factory-finished doors.
- E. Samples for Verification: Corner sections of doors, approximately **8 by 10 inches (200 by 250 mm)**, with door faces and edgings representing typical range of color and grain for each species of veneer and solid lumber required. Finish Sample with same materials proposed for factory-finished doors.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of door, from manufacturer.
- B. Sample Warranty: For special warranty.
- C. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- 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. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in opaque plastic bags or cardboard cartons.
- C. Mark each door on top and 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 (16 and 32 deg C) and relative humidity between 25 and 55 percent during remainder of construction period.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship, or have warped (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section, within specified warranty period.
 - 1. Warranty shall be in effect during the following period of time from date of Substantial Completion:
 - a. Exterior Doors: Five years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of stile and rail wood door from single manufacturer.

2.2 MATERIALS

- A. General: Use only materials that comply with referenced standards and other requirements specified.
 - 1. Assemble exterior doors and sidelites, including components, with wet-use adhesives complying with ASTM D 5572 for finger joints and with ASTM D 5751 for joints other than finger joints.

2. Assemble interior doors, including components, with either dry-use or wet-use adhesives complying with ASTM D 5572 for finger joints and with ASTM D 5751 for joints other than finger joints.
- B. **Regional Materials:** Wood doors shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.
- C. **Certified Wood:** Wood doors shall be certified as "FSC Pure" according to FSC STD-01-00 and FSC STD-40-004.
- D. **Adhesives:** Do not use adhesives that contain urea formaldehyde.
- E. **Composite Wood Products:** Products shall be made without urea formaldehyde.
- F. Panel Products: Veneer-core plywood.
- G. Safety Glass: Provide products complying with testing requirements in 16 CFR 1201, for Category II materials, unless those of Category I are expressly indicated and permitted.

2.3 EXTERIOR STILE AND RAIL WOOD DOORS

- A. Thermal Transmittance: Maximum whole fenestration product U-factor of **0.35 (1.98)**, according to AAMA 1503, ASTM E 1423, or NFRC 100.
- B. Exterior Stile and Rail Wood Doors: Exterior doors complying with WDMA I.S.6, "Industry Standard for Wood Stile and Rail Doors," and with other requirements specified.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [Belentry Doors LLC.](#)
 - b. [International Door and Latch.](#)
 - c. [JELD-WEN, Inc.](#)
 - d. [Karona, Inc.](#)
 - e. [QSM Enterprise, Inc.](#)
 - f. [Simpson Door Company.](#)
 2. Panel Designs: Indicated on Drawings. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
 3. Grade: Premium.
 4. Finish: Transparent.
 5. Wood Species: Cherry
 6. Door Construction for Transparent Finish:
 - a. Stile and Rail Construction: Veneered, structural composite lumber. Select veneers for similarity of grain and color, and arrange for optimum match between adjacent pieces. Use veneers not less than **1/16 inch (1.6 mm)** thick.
 - b. Raised-Panel Construction: Edge-glued, clear lumber; glued to both sides of a wood-based panel product. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.
 7. Stile and Rail Widths: Manufacturer's standard, but not less than the following:
 - a. Stiles, Top and Intermediate Rails: **5-3/8 inches (137 mm)**.
 - b. Bottom Rails: **11-3/8 inches (289 mm)**.
 8. Raised-Panel Thickness: **1-3/8 inches (35 mm)**.
 9. Molding Profile (Sticking): As selected by Architect from manufacturer's full range.

10. Glass: Uncoated, clear, fully tempered float glass, 5.0 mm thick, complying with Section 08 8000 "Glazing."
11. Mark, label, or otherwise identify stile and rail wood doors as complying with WDMA I.S.6 and grade specified. Include panel design number if applicable.

2.4 STILE AND RAIL WOOD DOOR FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels unless otherwise indicated:
 1. Clearances: Provide **1/8 inch (3 mm)** at heads, jambs, and between pairs of doors. Provide **1/2 inch (13 mm)** from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide not more than **3/8 inch (10 mm)** from bottom of door to top of threshold.
 - a. Comply with NFPA 80 for fire-rated doors.
 2. Bevel non-fire-rated doors **1/8 inch in 2 inches (3-1/2 degrees)** at lock and hinge edges.
 3. Bevel fire-rated doors **1/8 inch in 2 inches (3-1/2 degrees)** on lock edge; trim stiles and rails only to extent permitted by labeling agency.
- 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 measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
- C. Glazed Openings: Factory install glazing in doors, complying with Section 08 8000 "Glazing." Install glass using manufacturer's standard elastomeric glazing sealant complying with ASTM C 920. Secure glass in place with removable wood moldings. Miter wood moldings at corner joints.
- D. Transom and Side Panels: Fabricate panels to match adjoining doors in materials, finish, and quality of construction.
- E. Exterior Doors: Factory treat exterior doors after fabrication with water-repellent preservative to comply with WDMA I.S.4. Flash top of outswinging doors with manufacturer's standard metal flashing.
- F. Prehung Doors: Provide stile and rail doors complete with frames, weather stripping, and hardware.
 1. Provide hardware, including weather stripping, that complies with Section 08 7100 "Door Hardware."

2.5 FINISHING

- A. Finish wood doors at factory that are indicated to receive transparent finish.
- B. For doors indicated to be factory finished, comply with WDMA I.S.6A, "Industry Standard for Architectural Stile and Rail Doors," and with other requirements specified.
 1. Finish faces and all four edges of doors, including mortises and cutouts. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- C. Transparent Finish:
 1. Grade: Premium.
 2. Finish: WDMA TR-4 conversion varnish or WDMA TR-6 catalyzed polyurethane.
 3. Staining: Match Architect's sample.

4. Effect: Semifilled finish, produced by applying an additional finish coat to partially fill the wood pores.
5. Sheen: Semigloss.

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 08 7100 "Door Hardware."
- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
- 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 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or 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

SECTION 08 3113

ACCESS DOORS AND FRAMES

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. Access doors and frames for walls and ceilings.
- B. Related Requirements:
 - 1. Section 07 7200 "Roof Accessories" for roof hatches.
 - 2. Section 23 3300 "Air Duct Accessories" for heating and air-conditioning duct access doors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details materials, individual components and profiles, and finishes.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Detail fabrication and installation of access doors and frames for each type of substrate.
- C. Samples: For each door face material, at least **3 by 5 inches (75 by 125 mm)** in size, in specified finish.
- D. Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics according to the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.
 - 2. NFPA 288 for fire-rated access door assemblies installed horizontally.

2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acudor Products, Inc

2. [Babcock-Davis.](#)
 3. [Cendrex Inc.](#)
 4. [J. L. Industries, Inc.; Div. of Activar Construction Products Group.](#)
 5. [Lane-Aire Manufacturing Corp.](#)
 6. [Larsen's Manufacturing Company.](#)
 7. [Metropolitan Door Industries Corp.](#)
 8. [MIFAB, Inc.](#)
 9. [Milcor; Commercial Products Group of Hart & Cooley, Inc.](#)
 10. [Nystrom, Inc.](#)
 11. [Williams Bros. Corporation of America \(The\).](#)
- B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.
- C. Doors with Exposed Flanges:
1. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
 2. Locations: Wall and ceiling.
 3. Door Size: As required.
 4. Uncoated Steel Sheet for Door: Nominal **0.060 inch (1.52 mm)**, 16 gage
 - a. Finish: Factory prime.
 5. Frame Material: Same material, thickness, and finish as door.
 6. Hinges: Manufacturer's standard.
 7. Hardware: Latch
- D. Flush Access Doors with Concealed Flanges:
1. Assembly Description: Fabricate door to fit flush to frame. Provide frame with gypsum board beads for concealed flange installation.
 2. Locations: Wall and ceiling.
 3. Door Size: As required.
 4. Uncoated Steel Sheet for Door: Nominal **0.060 inch (1.52 mm)**, 16 gage.
 - a. Finish: Factory prime.
 5. Stainless-Steel Sheet for Door: Nominal **0.062 inch (1.59 mm)**, 16 gage.
 - a. Finish: No. 4.
 - b. At wet halls.
 6. Frame Material: Same material and thickness as door.
 7. Hinges: Manufacturer's standard.
 8. Hardware: Latch.
- E. Recessed Access Doors:
1. Assembly Description: Fabricate door in the form of a pan recessed **5/8 inch (16 mm)** for gypsum board infill. Provide frame with gypsum board bead for concealed flange installation.
 2. Locations: Wall and ceiling.
 3. Door Size: As required.
 4. Uncoated Steel Sheet for Door: Nominal **0.060 inch (1.52 mm)**, 16 gage.
 - a. Finish: Factory prime.
 5. Stainless-Steel Sheet for Door: Nominal **0.062 inch (1.59 mm)**, 16 gage.
 - a. Finish: No. 4.
 - b. At wet halls.
 6. Frame Material: Same material and thickness as door.
 7. Hinges: Manufacturer's standard.
 8. Hardware: Latch.

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. [Acudor Products, Inc](#)
 2. [Babcock-Davis](#).
 3. [Cendrex Inc.](#)
 4. [J. L. Industries, Inc.; Div. of Activar Construction Products Group.](#)
 5. [Lane-Aire Manufacturing Corp.](#)
 6. [Larsen's Manufacturing Company.](#)
 7. [Metropolitan Door Industries Corp.](#)
 8. [MIFAB, Inc.](#)
 9. [Milcor; Commercial Products Group of Hart & Cooley, Inc.](#)
 10. [Nystrom, Inc.](#)
 11. [Williams Bros. Corporation of America \(The\).](#)
- B. Fire-Rated, Flush Access Doors with Exposed Flanges:
1. Assembly Description: Fabricate door to fit flush to frame, uninsulated. Provide self-latching door with automatic closer and interior latch release. Provide manufacturer's standard-width exposed flange, proportional to door size.
 2. Locations: Wall and ceiling.
 3. Fire-Resistance Rating: Not less than that of adjacent construction.
 4. Uncoated Steel Sheet for Door: Nominal **0.060 inch (1.52 mm)**, 16 gage
 - a. Finish: Factory prime.
 5. Frame Material: Same material, thickness, and finish as door.
 6. Hinges: Manufacturer's standard.
 7. Latch and Lock: Self-closing, self-latching door hardware, operated by knurled-knob, with interior release.
- C. Fire-Rated, Flush Access Doors with Concealed Flanges:
1. Assembly Description: Fabricate door to fit flush to frame, uninsulated. Provide self-latching door with automatic closer and interior latch release. Provide manufacturer's standard-width exposed flange, proportional to door size.
 2. Locations: Wall and ceiling.
 3. Fire-Resistance Rating: Not less than that of adjacent construction.
 4. Uncoated Steel Sheet for Door: Nominal **0.060 inch (1.52 mm)**, 16 gage
 - a. Finish: Factory prime.
 5. Frame Material: Same material, thickness, and finish as door.
 6. Hinges: Manufacturer's standard.
 7. Latch and Lock: Self-closing, self-latching door hardware, operated by knurled-knob, with interior release.
- D. Hardware:
1. Latch: Cam latch operated by screwdriver.

2.4 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- C. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

- D. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304. Remove tool and die marks and stretch lines or blend into finish.
- E. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063.
- F. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- G. Frame Anchors: Same type as door face.
- H. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.5 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 attachment devices and fasteners of type required to secure access doors to types of supports indicated.
 - 1. For concealed flanges with drywall bead, provide edge trim for gypsum board and gypsum base securely attached to perimeter of frames.
 - 2. Provide mounting holes in frames for attachment of units to metal or wood framing.
 - 3. Provide mounting holes in frame for attachment of masonry anchors.
- D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.
 - 1. For recessed doors with plaster infill, provide self-furring expanded-metal lath attached to door panel.
- E. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
 - 1. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.
- F. Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.6 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.
- D. Steel and Metallic-Coated-Steel Finishes:
 - 1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
- E. Stainless-Steel Finishes:
 - 1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
 - 2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - a. Run grain of directional finishes with long dimension of each piece.
 - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - c. Directional Satin Finish: No. 4.

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.
- B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.3 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION

SECTION 08 4113

ALUMINUM AND STEEL-FRAMED ENTRANCES AND STOREFRONTS

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. Exterior and Interior storefront framing.
 - 2. Exterior and interior manual-swing entrance doors and door-frame units.
- B. Related Requirements:
 - 1. Section 07 9200 "Joint Sealants"
 - 2. Section 08 7100 "Door Hardware" for concealed closers at aluminum framed entrance systems
 - 3. Section 08 8000 "Glazing" for glass types installed in aluminum framed storefront and entrance systems and for fire rated glazing installed in fire rated frames and entrances.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

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.
- B. 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 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. Show Detail at concealed door closers installed at Aluminum Framed Entrances
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- 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: As indicated in Section 08 7100 "Door Hardware".
- G. Delegated-Design Submittal: For aluminum-framed entrances and storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and field testing agency.
- B. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.
 - 1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.
- C. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by a qualified testing agency.
- D. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality-control reports.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.
- B. Maintenance Data for Structural Sealant: For structural-sealant-glazed storefront to include in maintenance manuals. Include ASTM C 1401 recommendations for post-installation-phase quality-control program.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.

- C. 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.
- D. Mockups: Furnish Aluminum Storefront for installation in integrated exterior mockups specified in Section 04 2000 "Unit Masonry."

1.8 MOCKUPS

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Build mockup of typical wall area as shown on Drawings.
 - 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.

1.9 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: Five years from date of Substantial Completion.
- B. Special Finish Warranty: 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 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Warranty Period: 20 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 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, story drift, 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: At design wind pressure, as follows:
1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to **3/4 inch (19.1 mm)**, whichever is less.
 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: Where framing members overhang an anchor point, as follows:
 - a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus **1/4 inch (6.35 mm)** for spans greater than **11 feet 8-1/4 inches (3.6 m)** or 1/175 times span, for spans less than **11 feet 8-1/4 inches (3.6 m)**.
- E. Structural: Test according to ASTM E 330 as follows:
1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including 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. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
1. Fixed Framing and Glass Area:
 - a. Maximum air leakage of **0.06 cfm/sq. ft. (0.30 L/s per sq. m)** at a static-air-pressure differential of **6.24 lbf/sq. ft. (300 Pa)**.
 2. Entrance Doors:
 - a. Pair of Doors: Maximum air leakage of **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)**.
 - b. Single Doors: Maximum air leakage of **0.5 cfm/sq. ft. (2.54 L/s per sq. m)** at a static-air-pressure differential of **1.57 lbf/sq. ft. (75 Pa)**.
- G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than **10 lbf/sq. ft. (480 Pa)**.
- H. Water Penetration under Dynamic Pressure: Test according to 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 10 lbf/sq. ft. (480 Pa).
 2. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.
- I. Energy Performance: Certify and label energy performance according to NFRC as follows:
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K) as determined according to NFRC 100.
 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.35 as determined according to NFRC 200.
 3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 45 as determined according to NFRC 500.
- 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 according to 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).

2.2 ALUMINUM FRAMING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. [EFCO Corporation.](#)
 2. [Kawneer North America.](#)
 3. [Oldcastle Building Envelope.](#)
 4. [TRACO.](#)
 5. [YKK AP America Inc.](#)
- B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing, spandrel panels, and accessories, from single manufacturer.
1. Single source manufacturing and installation responsibility for storefront wall system, aluminum windows, and entrances within aluminum framed storefront systems including all components
- C. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Thermally broken at exterior, non-thermal at interior
 2. Glazing System: Retained mechanically with gaskets on four sides
 3. Glazing Plane: Front at exterior, center at interior
 4. Finish: High-Performance Organic Coating to Match Building A
 5. Fabrication Method: Field-fabricated stick system.

- D. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- E. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- F. Materials:
 - 1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: **ASTM B 209 (ASTM B 209M)**.
 - b. Extruded Bars, Rods, Profiles, and Tubes: **ASTM B 221 (ASTM B 221M)**.
 - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - d. Structural Profiles: ASTM B 308/B 308M.
 - 2. Steel Reinforcement: 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 according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
 - a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 - b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 - c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.3 ALUMINUM FRAMED ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
 - 1. Door Construction: **1-3/4-inch (44.5-mm)** minimum 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: Medium stile; **3-1/2-inch (88.9-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.

2.4 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 08 7100 "Door Hardware."
- B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article. Products are identified by using entrance door hardware designations as follows:
 - 1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in "Entrance Door Hardware Sets" Article.
 - 2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.
- C. Weather Stripping: Manufacturer's standard replaceable components.
 - 1. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.

2.5 GLAZING

- A. Glazing: Comply with Section 08 8000 "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.
- D. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L.
- E. Weatherseal Sealants: ASTM C 920 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.

2.6 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, fabricated from 300 series stainless steel.
- 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 A 123/A 123M or ASTM A 153/A 153M requirements.
- C. Concealed Flashing: Dead-soft, **0.018-inch- (0.457-mm-)** thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer.
- D. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for **30-mil (0.762-mm)** thickness per coat.
- E. Engineered Transition Assemblies
 - 1. Air Barrier Perimeter Seal to Windows, Doors, Curtain wall and Storefront Systems: Provide Proglaze Engineered Transition Assembly (ETA), manufactured by Tremco, Inc evaluated in accordance with the following properties:
 - a. ASTM E 283 Test Method for Determining Rate of Airflow Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen
 - b. ASTM E 330 Test Method for Structural Performance of Exterior Windows, Curtain Wall and Doors by Uniform Static Air Pressure Differential
 - c. ASTM E 331 Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Uniform Static Air pressure Difference
 - d. ASTM E 547 Test Method for Water penetration of Exterior Windows, Curtain walls and Doors by Cyclic Static Air Pressure Difference

2.7 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 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 head-and-sill-receptor system with shear blocks at intermediate horizontal members.
- F. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 - 1. At exterior doors, provide compression weather stripping at fixed stops.
 - 2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
- 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. Coordinate installation of concealed door closers installed at Aluminum Framed Entrances
- J. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 ALUMINUM FINISHES

- A. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent 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.
 - 1. Color: Match Building A

2.9 SOURCE QUALITY CONTROL

- A. Structural Sealant: Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

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 PREPARATION

- A. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure nonmovement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 6. Seal perimeter and other joints watertight unless otherwise indicated.
- B. 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.
- C. Set continuous sill members and flashing in full sealant bed as specified in Section 07 9200 "Joint Sealants" to produce weathertight installation.
- D. Install components plumb and true in alignment with established lines and grades.
- E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
- F. Install glazing as specified in Section 08 8000 "Glazing."
- G. Install weatherseal sealant according to Section 079200 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

- H. Entrance Doors: Install 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 according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.4 ERECTION TOLERANCES

- A. Erection Tolerances: 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.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of representative areas to determine compliance of installed system with specified requirements shall take place as follows and in successive stages as indicated on Drawings. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements
 - 1. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing under "Performance Requirements" Article, but not more than 0.09 cfm/sq. ft. (0.03 L/s per sq. m), of fixed wall area when tested according to ASTM E 783 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft. (300 Pa).
 - 2. Water Penetration: Areas shall be tested according to ASTM E 1105 at a minimum uniform and cyclic static-air-pressure difference of 0.67 times the static-air-pressure difference specified for laboratory testing under "Performance Requirements" Article, but not less than 4.18 lbf/sq. ft. (200 Pa), and shall not evidence water penetration.
 - 3. Water Spray Test: Before installation of interior finishes has begun, a minimum area of 75 feet (23 m) by 1 story of aluminum-framed systems designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
- C. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.

END OF SECTION

SECTION 08 7100

DOOR HARDWARE

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. Mechanical and electrified door hardware for:
 - a. Swinging doors.
 - 2. Electronic access control system components, including:
 - a. Electronic access control devices.
- B. Exclusions: Unless specifically listed in hardware sets, hardware is not specified in this section for:
 - 1. Windows
 - 2. Cabinets (casework), including locks in cabinets
 - 3. Signage
 - 4. Toilet accessories
 - 5. Overhead doors
- C. Related Sections:
 - 1. Division 01 Section "Alternates" for alternates affecting this section.
 - 2. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
 - 3. Division 09 sections for touchup finishing or refinishing of existing openings modified by this section.
 - 4. Division 13 Section "Radiation Protection" for requirements for lead-lining for door hardware at openings indicated to receive radiation protection.
 - 5. Division 26 sections for connections to electrical power system and for low-voltage wiring.
 - 6. Division 28 sections for coordination with other components of electronic access control system.

1.3 REFERENCES

- A. UL - Underwriters Laboratories

UL 10B - Fire Test of Door Assemblies

- 1. UL 10C - Positive Pressure Test of Fire Door Assemblies
 - 2. UL 1784 - Air Leakage Tests of Door Assemblies
 - 3. UL 305 - Panic Hardware
- B. DHI - Door and Hardware Institute
 - 1. Sequence and Format for the Hardware Schedule
 - 2. Recommended Locations for Builders Hardware
 - 3. Key Systems and Nomenclature

- C. ANSI - American National Standards Institute
 - 1. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties

1.4 SUBMITTALS

- A. General:
 - 1. Submit in accordance with Conditions of Contract and Division 01 requirements.
 - 2. Highlight, encircle, or otherwise specifically identify on submittals deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.
 - 3. Prior to forwarding submittal, comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, "EXAMINATION" article, herein.
- B. Action Submittals:
 - 1. Product Data: Product data including manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
 - 2. Riser and Wiring Diagrams: After final approval of hardware schedule, submit details of electrified door hardware, indicating:
 - a. Wiring Diagrams: For power, signal, and control wiring and including:
 - 1) Details of interface of electrified door hardware and building safety and security systems.
 - 2) Schematic diagram of systems that interface with electrified door hardware.
 - 3) Point-to-point wiring.
 - 4) Risers.
 - 3. Samples for Verification: If requested by Architect, submit production sample or sample installations of each type of exposed hardware unit in finish indicated, and tagged with full description for coordination with schedule.
 - a. Samples will be returned to supplier in like-new condition. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
 - 4. Door Hardware Schedule: Submit schedule with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Indicate complete designations of each item required for each door or opening, include:
 - a. Door Index; include door number, heading number, and Architects hardware set number.
 - b. Opening Lock Function Spreadsheet: List locking device and function for each opening.
 - c. Type, style, function, size, and finish of each hardware item.
 - d. Name and manufacturer of each item.
 - e. Fastenings and other pertinent information.
 - f. Location of each hardware set cross-referenced to indications on Drawings.
 - g. Explanation of all abbreviations, symbols, and codes contained in schedule.
 - h. Mounting locations for hardware.
 - i. Door and frame sizes and materials.
 - j. Name and phone number for local manufacturer's representative for each product.
 - k. Operational Description of openings with any electrified hardware (locks, exits, electromagnetic locks, electric strikes, automatic operators, door position switches, magnetic holders or closer/holder units, and access control components).

- Operational description should include how door will operate on egress, ingress, and fire and smoke alarm connection.
- 1) Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work that is critical in Project construction schedule.
5. Key Schedule:
 - a. After Keying Conference, provide keying schedule listing levels of keying as well as explanation of key system's function, key symbols used and door numbers controlled.
 - b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
 - c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
 - d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
 - e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion.
 - 1) Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
 - f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.
 6. Templates: After final approval of hardware schedule, provide templates for doors, frames and other work specified to be factory prepared for door hardware installation.
- C. Informational Submittals:
1. Qualification Data: For Supplier, Installer and Architectural Hardware Consultant.
 2. Product Certificates for electrified door hardware, signed by manufacturer:
 - a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
 3. Certificates of Compliance:
 - a. Certificates of compliance for fire-rated hardware and installation instructions if requested by Architect or Authority Having Jurisdiction.
 - b. Installer Training Meeting Certification: Letter of compliance, signed by Contractor, attesting to completion of installer training meeting specified in "QUALITY ASSURANCE" article, herein.
 - c. Electrified Hardware Coordination Conference Certification: Letter of compliance, signed by Contractor, attesting to completion of electrified hardware coordination conference, specified in "QUALITY ASSURANCE" article, herein.
 4. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by qualified testing agency, for door hardware on doors located in accessible routes.
 5. Warranty: Special warranty specified in this Section.
- D. Closeout Submittals:
1. Operations and Maintenance Data : Provide in accordance with Division 01 and include:
 - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
 - b. Catalog pages for each product.
 - c. Name, address, and phone number of local representative for each manufacturer.
 - d. Parts list for each product.

- e. Final approved hardware schedule, edited to reflect conditions as-installed.
- f. Final keying schedule
- g. Copies of floor plans with keying nomenclature
- h. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.
- i. Copy of warranties including appropriate reference numbers for manufacturers to identify project.

1.5 QUALITY ASSURANCE

- A. Product Substitutions: Comply with product requirements stated in Division 01 and as specified herein.
 - 1. Where specific manufacturer's product is named and accompanied by "No Substitute," including make or model number or other designation, provide product specified. (Note: Certain products have been selected for their unique characteristics and particular project suitability.)
 - a. Where no additional products or manufacturers are listed in product category, requirements for "No Substitute" govern product selection.
 - 2. Where products indicate "acceptable manufacturers" or "acceptable manufacturers and products", provide product from specified manufacturers, subject to compliance with specified requirements and "Single Source Responsibility" requirements stated herein.
- B. Supplier Qualifications and Responsibilities: Recognized architectural hardware supplier with record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that provides certified Architectural Hardware Consultant (AHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
 - 1. Warehousing Facilities: In Project's vicinity.
 - 2. Scheduling Responsibility: Preparation of door hardware and keying schedules.
 - 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.
 - 4. Coordination Responsibility: Coordinate installation of electronic security hardware with Architect and electrical engineers and provide installation and technical data to Architect and other related subcontractors.
 - a. Upon completion of electronic security hardware installation, inspect and verify that all components are working properly.
- C. Installer Qualifications: Qualified tradesmen, skilled in application of commercial grade hardware with record of successful in-service performance for installing door hardware similar in quantity, type, and quality to that indicated for this Project.
- D. Architectural Hardware Consultant Qualifications: 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 meets these requirements:
 - 1. For door hardware, DHI-certified, Architectural Hardware Consultant (AHC).
 - 2. Can provide installation and technical data to Architect and other related subcontractors.
 - 3. Can inspect and verify components are in working order upon completion of installation.
 - 4. Capable of producing wiring diagrams.
 - 5. Capable of coordinating installation of electrified hardware with Architect and electrical engineers.
- E. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.

1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated.
 2. Manufacturers that perform electrical modifications and that are listed by testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.
- F. Fire-Rated Door Openings: Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and are identical to products tested by Underwriters Laboratories, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.
- G. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to 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) at tested pressure differential of 0.3-inch wg (75 Pa) of water.
- H. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.
- I. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release latch. Locks do not require use of key, tool, or special knowledge for operation.
- J. Accessibility Requirements: For door hardware on doors in an accessible route, comply with governing accessibility regulations cited in "REFERENCES" article, herein.
1. Provide operating devices that do not require tight grasping, pinching, or twisting of wrist and that operate with force of not more than 5 lbf (22.2 N).
 2. 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 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 open position of 70 degrees, door will take at least 3 seconds to move to 3 inches (75 mm) from latch, measured to leading edge of door.
- K. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01.
1. Attendees: Owner, Contractor, Architect, Installer, Owner's security consultant, and Supplier's Architectural Hardware Consultant.
 2. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
 - a. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - b. Preliminary key system schematic diagram.
 - c. Requirements for key control system.
 - d. Requirements for access control.
 - e. Address for delivery of keys.
- L. Pre-installation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 2. Inspect and discuss preparatory work performed by other trades.
 3. Inspect and discuss electrical roughing-in for electrified door hardware.
 4. Review sequence of operation for each type of electrified door hardware.
 5. Review required testing, inspecting, and certifying procedures.
- M. Coordination Conferences:
1. Installation Coordination Conference: Prior to hardware installation, schedule and hold meeting to review questions or concerns related to proper installation and adjustment of door hardware.
 - a. Attendees: Door hardware supplier, door hardware installer, Contractor.
 - b. After meeting, provide letter of compliance to Architect, indicating when meeting was held and who was in attendance.
 2. Electrified Hardware Coordination Conference: Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.
 - a. Attendees: electrified door hardware supplier, doors and frames supplier, electrified door hardware installer, electrical subcontractor, Owner, Owner's security consultant, Architect and Contractor.
 - b. After meeting, provide letter of compliance to Architect, indicating when coordination conference was held and who was in attendance.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
 1. Deliver each article of hardware in manufacturer's original packaging.
- C. Project Conditions:
 1. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
 2. Provide secure lock-up for door hardware delivered to Project, but not yet installed. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- D. Protection and Damage:
 1. Promptly replace products damaged during shipping.
 2. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work.
 3. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- E. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.
- F. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.7 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- 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.
- F. Direct shipments not permitted, unless approved by Contractor.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Years from date of Substantial Completion, for durations indicated.
 - a. Closers:
 - 1) Mechanical: 30 Years for LCN, 10 years for Falcon SC.
 - b. Automatic Operators: 2 years.
 - c. Exit Devices:
 - 1) Mechanical: 3 years.
 - 2) Electrified: 1 year.
 - d. Locksets:
 - 1) Mechanical: 3 years.
 - 2) Electrified: 1 year.
 - e. Continuous Hinges: Lifetime warranty.
 - f. Key Blanks: Lifetime
 - 2. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.

1.9 MAINTENANCE

- A. Maintenance Tools:
 - 1. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Approval of manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.
- B. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.
- C. Hand of Door: Drawings show direction of slide, swing, or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.
- D. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.2 MATERIALS

- A. Fasteners
 - 1. Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.
 - 2. Furnish screws for installation with each hardware item. Finish exposed (exposed under any condition) screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
 - 3. Provide concealed fasteners for hardware units exposed when door is closed except when no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless thru-bolts are required to fasten hardware securely. Review door specification and advise Architect if thru-bolts are required.
 - 4. Install hardware with fasteners provided by hardware manufacturer.
- B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.
 - 1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

2.3 HINGES

- A. Provide five-knuckle, ball bearing hinges.
 - 1. Manufacturers and Products:
 - a. Scheduled Manufacturer and Product: Ives 5BB series
 - b. Acceptable Manufacturers and Products: Hager BB series, McKinney TB/T4B series
- B. Requirements:
 - 1. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
 - a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
 - b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high
 - 2. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
 - a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high

3. 2 inches or thicker doors:
 - a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
4. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
5. Where new hinges are specified for existing doors or existing frames, provide new hinges of identical size to hinge preparation present in existing door or existing frame.
6. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - a. Steel Hinges: Steel pins
 - b. Non-Ferrous Hinges: Stainless steel pins
 - c. Out-Swinging Exterior Doors: Non-removable pins
 - d. Out-Swinging Interior Lockable Doors: Non-removable pins
 - e. Interior Non-lockable Doors: Non-rising pins
7. Width of hinges: 4-1/2 inches (114 mm) at 1-3/4 inch (44 mm) thick doors, and 5 inches (127 mm) at 2 inches (51 mm) or thicker doors. Adjust hinge width as required for door, frame, and wall conditions to allow proper degree of opening.
8. Doors 36 inches (914 mm) wide or less furnish hinges 4-1/2 inches (114 mm) high; doors greater than 36 inches (914 mm) wide furnish hinges 5 inches (127 mm) high, heavy weight or standard weight as specified.
9. Provide hinges with electrified options as scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component.
10. Provide mortar guard for each electrified hinge specified, unless specified in hollow metal frame specification.
11. Provide spring hinges where specified. Provide two spring hinges and one bearing hinge per door leaf for doors 90 inches (2286 mm) or less in height. Provide one additional bearing hinge for each 30 inches (762 mm) of additional door height.

2.4 CONTINUOUS HINGES

A. Aluminum Geared

1. Manufacturers:
 - a. Scheduled Manufacturer: Ives.
 - b. Acceptable Manufacturers: Select, Stanley.
2. Requirements:
 - a. Provide aluminum geared continuous hinges conforming to ANSI/BHMA A156.25, Grade 2.
 - b. Provide aluminum geared continuous hinges, where specified in the hardware sets, fabricated from 6063-T6 aluminum, with 0.25-inch (6 mm) diameter Teflon coated stainless steel hinge pin.
 - c. Provide split nylon bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
 - d. Provide hinges capable of supporting door weights up to 450 pounds, and successfully tested for 1,500,000 cycles.
 - e. On fire-rated doors, provide aluminum geared continuous hinges that are classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
 - f. Provide aluminum geared continuous hinges with electrified option scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware.
 - g. Install hinges with fasteners supplied by manufacturer.
 - h. Provide hinges with symmetrical hole pattern.

2.5 ELECTRIC POWER TRANSFER

- A. Manufacturers:
 - a. Scheduled Manufacturer: Von Duprin
 - b. Acceptable Manufacturers: Falcon, ABH
- B. Provide power transfer with electrified options as scheduled in the hardware sets. Provide with number and gage of wires sufficient to accommodate electric function of specified hardware.
- C. Locate electric power transfer per manufacturer's template and UL requirements, unless interference with operation of door or other hardware items.

2.6 FLUSH BOLTS

- A. Manufacturers:
 - 1. Scheduled Manufacturer: Ives
 - 2. Acceptable Manufacturers: Burns, Trimco
- B. Requirements:
 - 1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

2.7 COORDINATORS

- A. Manufacturers:
 - 1. Scheduled Manufacturer: Ives
 - 2. Acceptable Manufacturers: Burns, Trimco
- B. Requirements:
 - 1. Where pairs of doors are equipped with automatic flush bolts, an astragal, or other hardware that requires synchronized closing of the doors, provide bar-type coordinating device, surface applied to underside of stop at frame head.
 - 2. Provide filler bar of correct length for unit to span entire width of opening, and appropriate brackets for parallel arm door closers and surface vertical rod exit device strikes. Factory-prep coordinators for vertical rod devices if required.

2.8 MORTISE LOCKS

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product: Schlage L9000 series
 - 2. Acceptable Manufacturers and Products: Best 45H series
- B. Requirements:
 - 1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1 Operational, Grade 1 Security, and manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance. Provide lock

case that is multi-function and field reversible for handing without opening case.
Cylinders: Refer to "KEYING" article, herein.

2. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1 inch (25 mm) throw, constructed of stainless steel.
3. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
4. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide a request to exit (RX) switch that is actuated with rotation of inside lever.
5. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.
 - a. Lever Design: Schlage 07L.
 - b. Tactile Warning (Knurling): Where required by authority having jurisdiction. Provide on levers on exterior (secure side) of doors serving rooms considered to be hazardous.

2.9 CYLINDRICAL LOCKS – GRADE 1

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Best 93K Series

B. Requirements:

1. Provide cylindrical locks conforming to ANSI/BHMA A156.2 Series 4000, Grade 1.
Cylinders: Refer to "KEYING" article, herein.
2. Provide locks with standard 2-3/4 inches (70 mm) backset, unless noted otherwise, with 1/2 inch latch throw. Provide proper latch throw for UL listing at pairs.
3. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
4. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
5. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
6. Provide electrified options as scheduled in the hardware sets.
7. Lever Trim: Solid cast levers without plastic inserts, and wrought roses on both sides.
 - a. Lever Design: Best 16D.
 - b. Tactile Warning (Knurling): Where required by authority having jurisdiction. Provide on levers on exterior (secure side) of doors serving rooms considered to be hazardous.

2.10 EXIT DEVICES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Von Duprin 98/35 series
2. Acceptable Manufacturers and Products: Sargent 80 series

B. Requirements:

1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1, and UL listed for Panic Exit or Fire Exit Hardware. Cylinders: Refer to "KEYING" article, herein.
2. Provide touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
3. Touchpad: Extend minimum of one half of door width. Match exit device finish, stainless steel for US26, US26D, US28, US32, and US32D finishes; and for all other finishes, provide compatible finish to exit device. Provide compression springs in devices, latches, and outside trims or controls; tension springs also acceptable.

4. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
5. Provide exit devices with manufacturer's approved strikes.
6. Provide exit devices cut to door width and height. Locate exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
7. Mount mechanism case flush on face of doors, or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
8. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion that is removed by use of a keyed cylinder, which is self-locking when re-installed.
9. Where lever handles are specified as outside trim for exit devices, provide heavy-duty lever trims with forged or cast escutcheon plates. Provide vandal-resistant levers that will travel to 90-degree down position when more than 35 pounds of torque are applied, and which can easily be re-set.
 - a. Lever Style: Match lever style of locksets.
 - b. Tactile Warning (Knurling): Where required by authority having jurisdiction. Provide on levers on exterior (secure side) of doors serving rooms considered to be hazardous.
10. Provide UL labeled fire exit hardware for fire rated openings.
11. Provide factory drilled weep holes for exit devices used in full exterior application, highly corrosive areas, and where noted in hardware sets.
12. Provide electrified options as scheduled.

2.11 POWER SUPPLIES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Schlage or Von Duprin PS900 series
2. Acceptable Manufacturers and Products: Dynalock 5000 series, Security Door Controls 600 series

B. Requirements:

1. Provide power supplies, recommended and approved by manufacturer of electrified locking component, for operation of electrified locks, electrified exit devices, magnetic locks, electric strikes, and other components requiring power supply.
2. Provide appropriate quantity of power supplies necessary for proper operation of electrified locking components as recommended by manufacturer of electrified locking components with consideration for each electrified component using power supply, location of power supply, and approved wiring diagrams. Locate power supplies as directed by Architect.
3. Provide regulated and filtered 24 VDC power supply , and UL class 2 listed.
4. Options:
 - a. Provide power supply, where specified, with internal capability of charging sealed backup batteries 24 VDC, in addition to operating DC load.
 - b. Provide sealed batteries for battery back-up at each power supply where specified.
 - c. Provide keyed power supply cabinet.
5. Provide power supply in an enclosure, complete, and requiring 120VAC to fused input.
6. Provide power supply with emergency release terminals, where specified, that allow release of all devices upon activation of fire alarm system complete with fire alarm input for initiating "no delay" exiting mode.

2.12 ROLLER LATCHES

- A. Manufacturers:
 - 1. Scheduled Manufacturer: Ives.
 - 2. Acceptable Manufacturers: Burns, Trimco.
- B. Requirements:
 - 1. Provide roller latches with 4-7/8 inches (124 mm) strike at single doors to fit ANSI frame prep. If dummy levers are used in conjunction with roller latch mount roller latch at a height as to not interfere with proper mounting and height of dummy lever.
 - 2. Provide roller latches 2-1/4 inches (57 mm) full lip strike at pair doors. Mount roller in top rail of each leaf per manufacturer's template.

2.13 CYLINDERS

- A. Manufacturers:
 - 1. Scheduled Manufacturer: Schlage, Best
- B. Requirements:
 - 1. Provide cylinders/cores, from the same manufacturer of locksets, compliant with ANSI/BHMA A156.5; latest revision, Section 12, Grade 1; permanent cylinders; cylinder face finished to match lockset, manufacturer's series as indicated. Refer to "KEYING" article, herein.
 - 2. Provide cylinders in the below-listed configuration(s), distributed throughout the Project as indicated.
 - a. Conventional cylinder with interchangeable core (SFIC) core with open keyway.
 - b. Keying: Manufacturer-keyed permanent cylinders/cores, configured into keying system per "KEYING" article herein.
 - c. Features: Cylinders/cores shall incorporate the following features.
 - 3. Nickel silver bottom pins.
 - 4. Replaceable Construction Cores.
 - a. Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
 - 1) 12 construction change (day) keys.
 - b. Owner or Owner's Representative will replace temporary construction cores with permanent cores.

2.14 KEYING

- A. Provide a factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.
- B. Requirements:
 - 1. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
 - a. Keying system as directed by the Owner.
 - 2. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements shall be cause for replacement of cylinders/cores involved at no additional cost to Owner.
 - 3. Provide keys with the following features.
 - a. Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
 - b. .
 - 4. Identification:

- a. Mark permanent cylinders/cores and keys with applicable blind code per DHI publication "Keying Systems and Nomenclature" for identification. Blind code marks shall not include actual key cuts.
 - b. Identification stamping provisions must be approved by the Architect and Owner.
 - c. Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
 - d. Failure to comply with stamping requirements shall be cause for replacement of keys involved at no additional cost to Owner.
 - e. Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
5. Quantity: Furnish in the following quantities.
- a. Change (Day) Keys: 3 per cylinder/core.
 - b. Permanent Control Keys: 3.
 - c. Master Keys: 6.
 - d. Unused balance of key blanks shall be furnished to Owner with the cut keys.
 - e. Extra Keys:
 - 1) 12 Presentation Keys
 - 2) 12 Construction Keys

2.15 KEY CONTROL SYSTEM

- A. Manufacturers:
1. Scheduled Manufacturer: Telkee
 2. Acceptable Manufacturers: HPC, Lund
- B. Requirements:
1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.
 - a. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
 - b. Provide hinged-panel type cabinet for wall mounting.

2.16 KEY MANAGEMENT SOFTWARE

- A. Manufacturers and Products:
1. Scheduled Manufacturer and Product: Schlage SITEMASTER 200
 2. Acceptable Manufacturers and Products: Best Keystone 600N.
- B. Requirements:
1. Software: Provide tracking, issuing, collecting and transferring information regarding keys. Provide customized query, reporting, searching capability, comprehensive location hardware listings, display key holder photos and signature for verification, and provide automatic reminders for maintenance, back-ups and overdue keys.
 2. Provide training for Owner's personnel on proper operation and application of key management software.

2.17 DOOR CLOSERS

- A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: LCN 4010/4110/4020 series
 2. Acceptable Manufacturers and Products: Sargent 281/281P10/281TJ series factory assembled (without PRV)
- B. Requirements:
1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. Stamp units with date of manufacture code.
 2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
 3. Cylinder Body: 1-1/2 inch (38 mm) diameter, with 5/8 inch (16 mm) diameter double heat-treated pinion journal.
 4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
 5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
 6. Hydraulic Regulation: By tamper-proof, non-critical valves with separate adjustment for latch speed, general speed, and backcheck.
 7. Provide closers with a solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers.
 8. Pressure Relief Valve (PRV) Technology: Not permitted.
 9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI/BHMA Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
 10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.18 DOOR CLOSERS

- A. Manufacturers and Products:
1. Scheduled Manufacturer and Product: Falcon SC70 series.
 2. Acceptable Manufacturers and Products: Norton 7500 series, LCN 4050 series.
- B. Requirements:
1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
 2. Provide door closers with fully hydraulic, full rack and pinion action with aluminum cylinder.
 3. Closer Body: 1-1/2 inch (38 mm) diameter with 5/8 inch (16 mm) diameter heat-treated pinion journal.
 4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
 5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
 6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
 7. Pressure Relief Valve (PRV) Technology: Not permitted.
 8. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.19 DOOR CLOSERS

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product: Falcon SC80/SC81 series
 - 2. Acceptable Manufacturers and Products: Norton 8501/8501BF series, LCN 1450 series.
- B. Requirements:
 - 1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory.
 - 2. Provide door closers with fully hydraulic, full rack and pinion action with aluminum cylinder.
 - 3. Closer Body: 1-1/4 inch (32 mm) diameter, with 5/8 inch (16 mm) diameter heat-treated pinion journal.
 - 4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
 - 5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
 - 6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
 - 7. Pressure Relief Valve (PRV) Technology: not permitted.
 - 8. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.20 ELECTRO-MECHANICAL AUTOMATIC OPERATORS

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product: LCN Senior Swing
 - 2. Acceptable Manufacturers and Products: Besam Swingmaster MP, Horton 4000LE series
- B. Requirements:
 - 1. Provide low energy automatic operator units that are electro-mechanical design complying with ANSI/BHMA A156.19.
 - a. Opening: Powered by DC motor working through reduction gears.
 - b. Closing: Spring force.
 - c. Manual, hydraulic, or chain drive closers: Not permitted.
 - d. Operation: Motor is off when door is in closing mode. Door can be manually operated with power on or off without damage to operator. Provide variable adjustments, including opening and closing speed adjustment.
 - e. Cover: Aluminum.
 - 2. Provide units with manual off/auto/hold-open switch, push and go function to activate power operator, vestibule interface delay, electric lock delay, hold-open delay adjustable from 2 to 30 seconds, and logic terminal to interface with accessories, mats, and sensors.
 - 3. Provide drop plates, brackets, or adapters for arms as required to suit details.
 - 4. Provide hard-wired motion sensors and/or actuator switches for operation as specified. Provide weather-resistant actuators at exterior applications.
 - 5. Provide key switches, with LED's, recommended and approved by manufacturer of automatic operator as required for function as described in operation description of hardware sets. Cylinders: Refer to "KEYING" article, herein.
 - 6. Provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer of automatic operator for each individual leaf. Actuators control both doors simultaneously at pairs. Sequence operation of exterior and vestibule doors with automatic operators to allow ingress or

egress through both sets of openings as directed by Architect. Locate actuators, key switches, and other controls as directed by Architect.

7. Provide units with inputs for smoke evacuation doors, where specified, which allow doors to power open upon fire alarm activation and hold open indefinitely or until fire alarm is reset, presence detector input, which prevents closed door from opening or door that is fully opened from closing, hold open toggle input, which allows remote activation for indefinite hold open and close second time input is activated, vestibule inputs, which allow sequencing operation of two units, and SPDT relay for interfacing with latching or locking devices.

2.21 DOOR TRIM

A. Manufacturers:

1. Scheduled Manufacturer: Ives
2. Acceptable Manufacturers: Burns, Trimco

B. Requirements:

1. Provide push plates 4 inches (102 mm) wide by 16 inches (406 mm) high by 0.050 inch (1 mm) thick and beveled 4 edges. Where width of door stile prevents use of 4 inches (102 mm) wide plate, adjust width to fit.
2. Provide push bars of solid bar stock, diameter and length as scheduled. Provide push bars of sufficient length to span from center to center of each stile. Where required, mount back to back with pull.
3. Provide offset pulls of solid bar stock, diameter and length as scheduled. Where required, mount back to back with push bar.
4. Provide flush pulls as scheduled. Where required, provide back-to-back mounted model.
5. Provide pulls of solid bar stock, diameter and length as scheduled. Where required, mount back to back with push bar.
6. Provide pull plates 4 inches (102 mm) wide by 16 inches (406 mm) high by 0.050 inch (1 mm) thick, beveled 4 edges, and prepped for pull. Where width of door stile prevents use of 4 inches (102 mm) wide plate, adjust width to fit.
7. Provide wire pulls of solid bar stock, diameter and length as scheduled.
8. Provide decorative pulls as scheduled. Where required, mount back to back with pull.

2.22 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer: Ives
2. Acceptable Manufacturers: Burns, Trimco

B. Requirements:

1. Provide kick plates, mop plates, and armor plates minimum of 0.050 inch (1 mm) thick as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Sizes of plates:
 - a. Kick Plates: 10 inches (254 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs
 - b. Mop Plates: 4 inches (102 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs
 - c. Armor Plates: 36 inches (914 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs

2.23 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

- A. Manufacturers:
 - 1. Scheduled Manufacturers: Glynn-Johnson
 - 2. Acceptable Manufacturers: Rixson, Sargent
- B. Requirements:
 - 1. Provide heavy duty concealed mounted overhead stop or holder as specified for exterior and interior vestibule single acting doors.
 - 2. Provide heavy duty concealed mounted overhead stop or holder as specified for double acting doors.
 - 3. Provide heavy or medium duty and concealed or surface mounted overhead stop or holder for interior doors as specified. Provide medium duty surface mounted overhead stop for interior doors and at any door that swings more than 140 degrees before striking wall, open against equipment, casework, sidelights, and where conditions do not allow wall stop or floor stop presents tripping hazard.
 - 4. Where overhead holders are specified provide friction type at doors without closer and positive type at doors with closer.

2.24 DOOR STOPS AND HOLDERS

- A. Manufacturers:
 - 1. Scheduled Manufacturer: Ives
 - 2. Acceptable Manufacturers: Burns, Trimco
- B. Provide door stops at each door leaf:
 - 1. Provide wall stops wherever possible. Provide convex type where mortise type locks are used and concave type where cylindrical type locks are used.
 - 2. Where a wall stop cannot be used, provide universal floor stops for low or high rise options.
 - 3. Where wall or floor stop cannot be used, provide medium duty surface mounted overhead stop.

2.25 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

- A. Manufacturers:
 - 1. Scheduled Manufacturer: National Guard
 - 2. Acceptable Manufacturers: Reese, Zero International
- B. Requirements:
 - 1. Provide thresholds, weatherstripping (including door sweeps, seals, astragals) and gasketing systems (including smoke, sound, and light) as specified and per architectural details. Match finish of other items.
 - 2. Size of thresholds:
 - a. Saddle Thresholds: 1/2 inch (13 mm) high by jamb width by door width
 - b. Bumper Seal Thresholds: 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width
 - 3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.

2.26 SILENCERS

- A. Manufacturers:

1. Scheduled Manufacturer: Ives
2. Acceptable Manufacturers: Burns, Trimco

B. Requirements:

1. Provide "push-in" type silencers for hollow metal or wood frames.
2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
3. Omit where gasketing is specified.

2.27 MAGNETIC HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer: LCN
2. Acceptable Manufacturers: Rixson, Sargent

B. Requirements:

1. Provide wall or floor mounted electromagnetic door release as specified with minimum of 25 pounds of holding force. Coordination projection of holder and armature with other hardware and wall conditions to ensure that door sits parallel to wall when fully open. Wire magnetic holders on fire-rated doors into the fire control panel for fail-safe operation.

2.28 DOOR POSITION SWITCHES

A. Manufacturers:

1. Scheduled Manufacturer: Schlage
2. Acceptable Manufacturers: GE-Interlogix, Sargent

B. Requirements:

1. Provide recessed or surface mounted type door position switches as specified.
2. Coordinate door and frame preparations with door and frame suppliers. If switches are being used with magnetic locking device, provide minimum of 4 inches (102 mm) between switch and magnetic locking device.

2.29 FINISHES

A. Finish: BHMA 626/652 (US26D); except:

1. Hinges at Exterior Doors: BHMA 630 (US32D)
2. Continuous Hinges: BHMA 628
3. Push Plates, Pulls, and Push Bars: BHMA 630 (US32D)
4. Protection Plates: BHMA 630 (US32D)
5. Overhead Stops and Holders: BHMA 630 (US32D)
6. Door Closers: Powder Coat to Match
7. Wall Stops: BHMA 630 (US32D)
8. Weatherstripping: Clear Anodized Aluminum
9. Thresholds: Mill Finish Aluminum

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to installation of hardware, 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.
- 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. Where on-site modification of doors and frames is required:
 - 1. Carefully remove existing door hardware and components being reused. Clean, protect, tag, and store in accordance with storage and handling requirements specified herein.
 - 2. Field modify and prepare existing door and frame for new hardware being installed.
 - 3. When modifications are exposed to view, use concealed fasteners, when possible.
 - 4. Prepare hardware locations and reinstall in accordance with installation requirements for new door hardware and with:
 - a. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.
 - b. Wood Doors: DHI WDHS.5 "Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors."
 - c. Doors in rated assemblies: NFPA 80 for restrictions on on-site door hardware preparation.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights 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 WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- C. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- D. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- E. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- F. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.

- G. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity 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.
- H. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - 1. Replace construction cores with permanent cores as indicated in keying section.
- I. Wiring: Coordinate with Division 26, ELECTRICAL sections for:
 - 1. Conduit, junction boxes and wire pulls.
 - 2. Connections to and from power supplies to electrified hardware.
 - 3. Connections to fire/smoke alarm system and smoke evacuation system.
 - 4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
 - 5. Testing and labeling wires with Architect's opening number.
- J. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
- K. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Closers shall not be visible in corridors, lobbies and other public spaces unless approved by Architect.
- L. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.
- M. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- N. 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 may impede traffic or present tripping hazard.
- O. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- P. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- Q. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

- A. Architectural Hardware Consultant: Engage qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
 - 1. 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.

- B. Occupancy Adjustment: Approximately three (3) 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 door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

- A. Provide training for Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration and Training."

3.8 DOOR HARDWARE SCHEDULE

- A. Locksets, exit devices, and other hardware items are referenced in the following hardware sets for series, type and function. Refer to the above-specifications for special features, options, cylinders/keying, and other requirements.

- B. Hardware Sets:

Hardware Set No. 01

Door #(s):

100A

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
2	EA	CONT. HINGE	224HD EPT	628	IVE
2	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL+-3547A-DT-OP	626	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL+-3547A-NL-OP	626	VON
1	EA	SFIC MORTISE CYL.	80-133	626	SCH
1	EA	SFIC CORE	80-033	626	SCH
2	EA	VERT. PULLS	RM 3302 TYPE 12 MOUNT FULL HT	630	ROCK
1	EA	SURFACE CLOSER	4111 CUSH	689	LCN
1	EA	SURF. AUTO OPERATOR	9542 HL/D MS	ANCLR	LCN
1	EA	CONC OH STOP	100S (For use with Operator Leaf)	630	GLY
1	EA	WEATHER RING	8310-801	PLA	LCN
1	EA	ACTUATOR, WALL MOUNT	8310-855 (Mount in Vestibule)	630	LCN
1	EA	ACTUATOR, WALL MOUNT	8310-853T (Mount in Exterior)	630	LCN
1	EA	BOLLARD/ACTUATOR POST	CE-916-635-SS	630	CURRAN
1	EA	DRIP CAP	16A	CL	NGP
1	EA	PERIMETER GASKET	BY DOOR/FRAME MANUFACTURER		
2	EA	DOOR SWEEP	100VA	CL	NGP
1	EA	THRESHOLD	513	AL	NGP
1	EA	CREDENTIAL READER	BY SECURITY SECTION (Mount in Bollard)		
2	EA	DOOR CONTACT	679-05	WHT	SCE
1	EA	POWER SUPPLY	PS902 900-BB 900-4RL KL900	LGR	VON

Operational Description:

Doors normally closed and secure.

Free Egress at all times by push pad or activating operator actuator.

Access by key override or presentation of a valid credential to the reader which allows entry by door pull or operator.

Doors remain secure with loss of power or activation of fire alarm.

DPS monitors door open/closed position, RX shunts DPS signaling a legal exit to security systems.

Provide bollard/actuator post at door B119A. Door C100 to receive wall mounted actuator.

Mount card reader and ADA actuator in bollard post (locate bollard as directed by Architect).
 8310-855 ADA actuator mounted in vestibule (locate as directed by Architect) independently controls
 Door B119A.1/C100.1 and Door B119A/C100 (Set 05).

Hardware Set No. 02

Door #(s):

012F 102

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
1	EA	CONT. HINGE	224HD EPT	628	IVE
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL+-35A-NL-OP	626	VON
1	EA	SFIC RIM CYLINDER	80-159	626	SCH
1	EA	SFIC CORE	80-033	626	SCH
1	EA	VERT. PULLS	RM 3302 TYPE 12 MOUNT FULL HT	630	ROCK
1	EA	SURFACE CLOSER	4111 CUSH	689	LCN
1	EA	DRIP CAP	16A	CL	NGP
1	EA	PERIMETER GASKET	BY DOOR/FRAME MANUFACTURER		
1	EA	DOOR SWEEP	100VA	CL	NGP
1	EA	THRESHOLD	513	AL	NGP
1	EA	CREDENTIAL READER	BY SECURITY SECTION		
1	EA	DOOR CONTACT	679-05	WHT	SCE

Operational Description:

Door normally closed and secure.
 Free Egress at all times by push pad.
 Access by key override or presentation of a valid credential to the reader which allows entry by door pull.
 Doors remain secure with loss of power or activation of fire alarm.
 DPS monitors door open/closed position, RX shunts DPS signaling a legal exit to security systems.

Hardware Set No. 03

Door #(s):

100B

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
2	EA	CONT. HINGE	224HD	628	IVE
2	EA	DUMMY PUSH BAR	350	626	VON
2	EA	VERT. PULLS	RM 3302 TYPE 12 MOUNT FULL HT	630	ROCK
1	EA	SURFACE CLOSER	4111 CUSH	689	LCN
1	EA	SURF. AUTO OPERATOR	9542 HL/D MS	ANCLR	LCN
1	EA	CONC OH STOP	100S (For use with Operator Leaf)	630	GLY
1	EA	ACTUATOR, JAMB MOUNT	8310-818T	630	LCN
1	EA	PERIMETER GASKET	BY DOOR/FRAME MANUFACTURER		
2	EA	DOOR SWEEP	100VA	CL	NGP

Operational Description:

Doors are push/pull - free Egress/Access at all times by push pad/door pull or activating operator actuator.

8310-855 ADA actuator mounted in vestibule (specified in Set 01-A) independently controls interior and exterior doors at vestibule.

Hardware Set No. 4

Door #(s):
101S

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
6	EA	POCKET PIVOT HINGE	91105F	US32	IVE
2	EA	SVR FIRE EXIT HARDWARE	9827-L-BE-F-LBR-07	626	VON
2	EA	SURFACE CLOSER	SC71 REG OR PA AS REQ	689	FAL
2	EA	KICK PLATE	8400 10" X 1 1/2" LDW B4E	630	IVE
2	EA	FIRE/LIFE WALL MAG	SEM7850	689	LCN
1	SET	SEALS	2525B	BRN	NGP
1	EA	SEALS	5070B (MEETING STILE)	BRN	NGP

Operational Description:

Free Egress/Access at all times.

Magnetic Hold Open is continuously energized allowing the doors to be held open under normal building conditions. When the Fire Alarm is activated, power to the Magnetic Hold Open is disconnected causing the doors to close automatically.

Hardware Set No. 4A

Door #(s):
001S, 201S

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	SVR FIRE EXIT HARDWARE	9827-L-BE-F-LBR-07	626	VON
1	EA	SURFACE CLOSER	SC71 REG OR PA AS REQ	689	FAL
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B4E	630	IVE
1	EA	FIRE/LIFE WALL MAG	SEM7850	689	LCN
1	SET	SEALS	2525B	BRN	NGP
1	EA	SEALS	5070B (MEETING STILE)	BRN	NGP

Operational Description:

Free Egress/Access at all times.

Magnetic Hold Open is continuously energized allowing the doors to be held open under normal building conditions. When the Fire Alarm is activated, power to the Magnetic Hold Open is disconnected causing the doors to close automatically.

Hardware Set No. 5

Door #(s):

001

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
6	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	SET	FLUSH BOLT	FB358P/FB458P AS REQ'D	630	IVE
1	EA	DUST PROOF STRIKE	DP2	626	IVE
1	EA	STOREROOM LOCK	9K-7-D-16D	626	BES
1	EA	PERMANENT CORE	PER FACILITY KEY SYSTEM	626	BES
2	EA	KICK PLATE	8400 10" X 1 1/2" LDW B4E	630	IVE
2	EA	WALL STOP	WS406/407CCV	630	IVE
2	EA	SILENCER	SR64	GRY	IVE

Hardware Set No. 6

Door #(s):

002, 003

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	9K-7-D-16D	626	BES
1	EA	PERMANENT CORE	PER FACILITY KEY SYSTEM	626	BES
1	EA	SURFACE CLOSER	SC81 REG OR PA AS REQ	689	FAL
1	EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	SET	SEALS	2525B	BRN	NGP

Hardware Set No. 7

Door #(s):

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	9K-7-D-16D	626	BES
1	EA	PERMANENT CORE	PER FACILITY KEY SYSTEM	626	BES
1	EA	SURFACE CLOSER	SC81 REG OR PA AS REQ (Template for 180 degree swing where door opens 180)	689	FAL
1	EA	SURFACE CLOSER	SC81 SS (Door C107 Only)	689	FAL
1	EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	SET	SEALS	2525B	BRN	NGP
1	EA	DOOR SWEEP	OV634A (EMR Only)	CL	NGP

Hardware Set No. 8

Door #(s):

007A,007B,
007C, 007D,
104A, 104B

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	OFFICE LOCK	9K-7-B-16D	626	BES
1	EA	PERMANENT CORE	PER FACILITY KEY SYSTEM	626	BES
1	EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware Set No. 9

Door #(s):

007

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	OFFICE LOCK	9K-7-B-16D	626	BES
1	EA	SURFACE CLOSER	SC81 REG OR PA AS REQ	689	FAL
1	EA	PERMANENT CORE	PER FACILITY KEY SYSTEM	626	BES
1	EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware Set No. 10

Door #(s):

107, 202

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CLASSROOM LOCK	9K-7-R-16D	626	BES
1	EA	SURFACE CLOSER	SC81 REG OR PA AS REQ	689	FAL
1	EA	PERMANENT CORE	PER FACILITY KEY SYSTEM	626	BES
1	EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware Set No. 11

Door #(s):

202a 202B
202C 202D

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CLASSROOM LOCK	9K-7-R-16D	626	BES
1	EA	PERMANENT CORE	PER FACILITY KEY SYSTEM	626	BES
1	EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware Set No. 12

Door #(s):

005, 006, 105,
106, C103,
C105

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK	9K-0-L-16D	626	BES
1	EA	SURFACE CLOSER	SC81 REG OR PA AS REQ	689	FAL
1	EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1	EA	MOP PLATE	8400 6" X 1" LDW B4E	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware Set No. 13

Door #(s):

004, 104A

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
6	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CLASSROOM LOCK	9K-7-R-16D	626	BES
1	EA	DOUBLE DUMMY TRIM	9K-7-2DT-16D		
1	SET	MANUAL FLUSH BOLT (TOP AND BOTTOM)	FB457	US26D	IVE
1	EA	PERMANENT CORE	PER FACILITY KEY SYSTEM	626	BES
1	EA	KICK PLATE	8400 10" X 2" LDW B4E	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware Set No. 14

Door #(s):

000 000B

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
6	EA	HW HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	SET	MANUAL FLUSH BOLT (TOP AND BOTTOM)	FB457	US26D	IVE
1	EA	DUST PROOF STRIKE	DP2	626	IVE
1	EA	STOREROOM LOCK	9K-7-D-16D	626	BES
1	EA	PERMANENT CORE	PER FACILITY KEY SYSTEM	626	BES
2	EA	SURFACE CLOSER	SC81 REG OR PA AS REQ	689	FAL
2	EA	KICK PLATE	8400 10" X 1 1/2" LDW B4E	630	IVE
2	EA	WALL STOP	WS406/407CCV	630	IVE
1	SET	SEALS	2525B	BRN	NGP
1	EA	SEALS	5070B (MEETING STILE)	BRN	NGP
2	EA	DOOR SWEEP	OV634A	CL	NGP

Hardware Set No. MISC

Door #(s):

KNOX BOX

Each To Have:

Qty		Description	Catalog Number	Finish	Mfr
2	EA	KNOX BOX	3266 (Surface Mount) with PS# PS-39-001509-85 cylinder.	DKBR	KNX

Note:

One Knox Box for each building - Locate as directed by Architect. Coordinate with Baltimore County Fire Marshals Office 700 East Joppa Road FL 4 Towson, MD 21286-5505.

End of Section

SECTION 08 8000

GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

A. Section includes:

1. Glass for windows, doors, interior borrowed lites, storefront framing and glazed curtainwalls.
2. Glazing sealants and accessories.

B. Related Sections:

1. Section 08 8300 "Mirrors."

1.3 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 according to ASTM C 1036.

C. IBC: International Building Code.

D. Interspace: Space between lites of an insulating-glass unit.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Sustainable Design Submittals:

1. [Product Data](#): For sealants, indicating VOC content.

C. Glass Samples: For each type of glass product other than clear monolithic vision glass; **12 inches (300 mm)** square.

1. Coated glass.
2. Laminated glass.
3. Insulating glass.

- D. Glazing Accessory Samples: For gaskets sealants and colored spacers, in 12-inch (300-mm) lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
- E. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
- F. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For installers manufacturers of insulating-glass units with low-e coatings, glass testing agency, and sealant testing agency.
- B. Product Certificates: For glass and glazing products, from manufacturer.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for coated glass, insulating glass, glazing sealants and glazing gaskets.
 - 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- D. Preconstruction adhesion and compatibility test report.
- E. Warranties: Sample of special warranties.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.
- B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
- E. 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 for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F (250 deg C), and the fire-resistance rating in minutes.
- F. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
 - 1. Install glazing in mockups specified in Section 08 5200 "Wood Windows" and Section 08 4413 "Glazed Aluminum Curtain Walls" to match glazing systems required for Project, including glazing methods.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
 1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
 2. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
 3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
 4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
 5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to 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 recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 PROJECT 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).

1.11 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass 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 on Laminated Glass: Manufacturer's standard form in which 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 on Insulating Glass: Manufacturer's standard form in which 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 the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Subject to compliance with requirements, provide glass products by PPG or a comparable product by one of the following:
 - 1. [Guardian Glass; SunGuard.](#)
 - 2. [Pilkington North America.](#)
 - 3. [Vetrotech Saint-Gobain.](#)
 - 4. [Viracon, Inc.](#)
- B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
- C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 GLASS PRODUCTS, GENERAL

- A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
 - 1. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
- B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

2.3 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 the following: 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 01 4000 "Quality Requirements," to design glazing.
- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
 - 1. Design Wind Pressures: As indicated on Drawings.
 - 2. Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.

- a. Wind Design Data: As indicated on Drawings.
3. 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.
- 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, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as $\text{Btu/sq. ft.} \times \text{h} \times \text{deg F}$ ($\text{W/sq. m} \times \text{K}$).
 5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
 6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.4 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. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
 2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
 3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
 4. 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 or manufacturer. 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 IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the 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.

2.5 GLASS PRODUCTS

- A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- B. Ultraclear Float Glass: ASTM C 1036, Type I, Class I (clear), Quality-Q3;
 - 1. Basis of Design: Subject to compliance with requirements, provide ultraglass products by PPG Starphie or a comparable product by one of the following:
 - a. [Guardian Industries Corp.](#); Ultrawhite.
 - b. [Pilkington North America](#); Optiwhite.
- C. Fully Tempered Float Glass: ASTM C 1048, 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.
- D. Ceramic-Coated Spandrel Glass: ASTM C 1048, Condition B, Type I, Quality-Q3, and complying with other requirements specified.
 - 1. Glass: Clear float.
 - 2. Ceramic Coating Color: Match Architect's Sample.

2.6 LAMINATED GLASS

- A. Laminated Glass: ASTM C 1172. 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 ionomeric polymer 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.

2.7 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
 - 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.

2.8 FIRE-PROTECTION-RATED GLAZING

- A. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies and NFPA 257 for window assemblies.
- B. Laminated Ceramic Glazing: Laminated glass made from 2 plies of clear, ceramic flat glass; **5/16-inch (8-mm)** total nominal thickness; complying with testing requirements in 16 CFR 1201 for Category II materials.
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Nippon Electric Glass Co., Ltd. \(distributed by Technical Glass Products\); FireLite Plus.](#)
 - b. [Schott North America, Inc.; Laminated Pyran Crystal.](#)
 - c. [Vetrotech Saint-Gobain; SGG Keralite FR-L.](#)

- C. Laminated Glass with Intumescent Interlayers: Laminated glass made from multiple plies of uncoated, clear float glass; with intumescent interlayers; complying with testing requirements in 16 CFR 1201 for Category II materials.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [InterEdge, Inc., a subsidiary of AFG Industries, Inc.; Pyrobel.](#)
 - b. [Pilkington Group Limited \(distributed by Technical Glass Products\); PyroStop.](#)
 - c. [Vetrotech Saint-Gobain](#); SGG Contraflam N2 or SGG Swissflam N2.

2.9 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
1. Neoprene complying with ASTM C 864.
 2. EPDM complying with ASTM C 864.
 3. Silicone complying with ASTM C 1115.
 4. Thermoplastic polyolefin rubber complying with ASTM C 1115.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene EPDM silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.
- C. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock-strips, complying with ASTM C 542, black.

2.10 GLAZING SEALANTS

- A. General:
1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will 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. Sealants used inside the weatherproofing system, shall have a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Dow Corning Corporation; 790.](#)
 - b. [GE Advanced Materials - Silicones; SilPruf LM SCS2700.](#)
 - c. [May National Associates, Inc.; Bondaflex Sil 290.](#)
 - d. [Pecora Corporation; 890.](#)
 - e. [Sika Corporation, Construction Products Division; SikaSil-C990.](#)
 - f. [Tremco Incorporated; Spectrem 1.](#)

- C. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

2.11 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 C 1281 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.

2.12 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of 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: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- G. Perimeter Insulation for Fire-Resistive 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.

2.13 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.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.

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 will 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 is glass with edge damage or other imperfections that, when installed, could weaken glass 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 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 according to 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. 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 by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Center glass lites in openings on setting blocks and press firmly against tape 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.
- G. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 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 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 by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 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.

3.7 LOCK-STRIP GASKET GLAZING

- A. Comply with ASTM C 716 and gasket manufacturer's written instructions. Provide supplementary wet seal and weep system unless otherwise indicated.

3.8 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. 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; remove as recommended in writing by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
- E. Wash glass on both exposed surfaces in each area of Project 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.

3.9 MONOLITHIC GLASS SCHEDULE

- A. Glass Type: Clear float glass.
 - 1. Thickness: 6.0 mm.
 - 2. Glass shall be annealed, heat-strengthened or tempered as required by codes and as specified on drawings.

3.10 LAMINATED GLASS TYPES

- A. Glass Type: Clear laminated glass with two plies of annealed float glass and decorative interlayer.
 - 1. Minimum Thickness of first Glass Ply: 3 mm.
 - 2. Interlayer Thickness: 0.030 inch (0.76 mm).
 - 3. Minimum Thickness of second Glass Ply: 6 mm.
 - 4. Glass shall be annealed, heat-strengthened or tempered as required by codes and as specified on drawings

3.11 INSULATING GLASS SCHEDULE

- A. Glass Type : Low-e-coated, ultra-clear insulating glass.
 - 1. Outdoor Lite: Ultraclear float glass.
 - 2. Indoor Lite: Ultraclear float glass.
 - 3. Glass shall be annealed, heat-strengthened or tempered as required by codes and specified on drawings
 - 4. Glazing Type 1: Basis of Design at South and West walls: PPG Industries, Inc.: Solarban 70xl, Starphire.
 - a. Winter U-Value: 0.28
 - b. SHGC: 0.27 max
 - c. Visible Transmittance: 64% minimum
- B. Glass Type: Translucent Insulating glass unit
 - 1. Basis of Design: PPG Industries, Inc.: Solarban 70xl, Starphire
 - a. Winter U-Value: 0.25
 - b. SHGC: 0.27 max
 - c. Visible Transmittance: 62%
 - 2. Overall Unit Thickness: 1 inch (25 mm)
 - 3. Thickness of Each Glass Lite: 6.0 mm.
 - 4. Outdoor Lite: Ultraclear float glass.

3.12 FIRE-PROTECTION-RATED GLAZING TYPES

- A. Glass Type : 45-minute fire-protection-rated glazing with 450 deg F (250 deg C) temperature-rise limitation; laminated glass with intumescent interlayers.
 - 1. Provide safety glazing labeling.

END OF SECTION

SECTION 08 8300

MIRRORS

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 the following types of silvered flat glass mirrors:
 - 1. Annealed monolithic glass mirrors.
 - 2. Film-backed glass mirrors qualifying as safety glazing.
- B. Related Sections:
 - 1. Section 08 8000 "Glazing" for glass with reflective coatings used for vision and spandrel lites.
 - 2. Section 10 2800 "Toilet, Bath, and Laundry Accessories" for metal-framed mirrors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
- C. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work.
- D. Samples: For each type of the following products:
 - 1. Mirrors: 12 inches (300 mm) square, including edge treatment on two adjoining edges.
 - 2. Mirror Clips: Full size.
 - 3. Mirror Trim: 12 inches (300 mm) long.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Certificates: For each type of mirror and mirror mastic, from manufacturer.
- C. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing, paint, film and substrates on which mirrors are installed.
- D. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For mirrors to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- B. Glazing Publications: Comply with the following published recommendations:
1. GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glass and glazing terms not otherwise defined in this Section or in referenced standards.
 2. GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."
- C. Safety Glazing Products: For film-backed mirrors, provide products complying with testing requirements in 16 CFR 1201 for Category II materials.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which mirror manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
1. Warranty Period: **Five** 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. Avalon Glass and Mirror Company.
 2. Binswanger Mirror; a division of Vitro America, Inc.
 3. D & W Incorporated.
 4. Donisi Mirror Company.

5. [Gardner Glass, Inc.](#)
6. [Gilded Mirrors, Inc.](#)
7. [Glasswerks LA, Inc.](#)
8. [Guardian Glass; SunGuard.](#)
9. [Head West.](#)
10. [Independent Mirror Industries, Inc.](#)
11. [Lenoir Mirror Company.](#)
12. [National Glass Industries.](#)
13. [Stroupe Mirror Co., Inc.](#)
14. [Sunshine Mirror.](#)
15. [Trulite Glass & Aluminum Solutions, LLC.](#)
16. [Virginia Mirror Company, Inc.](#)
17. [Walker Glass Co., Ltd.](#)

B. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.

C. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.

2.2 SILVERED FLAT GLASS MIRRORS

A. Mirrors, General: ASTM C 1503; manufactured using copper-free, low-lead mirror coating process.

B. Annealed Monolithic Glass Mirrors: Mirror Select Quality, ultraclear (low-iron) float glass with a minimum 91 percent visible light transmission.

1. Nominal Thickness: 6.0 mm.

C. Laminated Mirrors: ASTM C 1172, Type II.

1. Glass for Outer Lite: Annealed float glass, Mirror Select Quality, ultraclear (low-iron) float glass with a minimum 91 percent visible light transmission.
2. Nominal Thickness for Outer Lite: 3.0 mm.
3. Glass for Inner Lite: Annealed float glass; ASTM C 1036, Type I (transparent flat glass), Quality-Q3; Class 1 (clear).
4. Nominal Thickness: 3.0 mm.
5. Interlayer: Mirror manufacturer's standard **0.030-inch- (0.76-mm-)** thick, clear polyvinyl-butyl interlayer with a proven record of showing no tendency to delaminate from, or cause damage to, silver coating.

D. Safety Glazing Products: For film-backed mirrors, provide products that comply with 16 CFR 1201, Category II.

2.3 MISCELLANEOUS MATERIALS

A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.

C. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

- a. [Franklin International; Titebond Division.](#)
 - b. [Laurence, C. R. Co., Inc.](#)
 - c. [Macco Adhesives; Liquid Nails Division.](#)
 - d. [OSI Sealants, Inc.](#)
 - e. [Palmer Products Corporation.](#)
 - f. [Pecora Corporation.](#)
 - g. [Royal Adhesives & Sealants; Gunther Mirror Mastics Division.](#)
 - h. [Sommer & Maca Industries, Inc.](#)
2. Adhesive shall have a VOC content of not more than 70 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

2.4 MIRROR HARDWARE

- A. Aluminum J-Channels and Cleat: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.
1. Bottom Trim: J-channels formed with front leg and back leg not less than **5/16 and 3/4 inch (7.9 and 19 mm)** in height, respectively.
 - a. [Manufacturers:](#) Subject to compliance with requirements, provide products by the following:
 - 1) [Laurence, C. R. Co., Inc.](#)
 2. Top Trim: Formed with front leg with a height matching bottom trim and back leg designed to fit into the pocket created by wall-mounted aluminum cleat.
 - a. [Manufacturers:](#) Subject to compliance with requirements, provide products by the following:
 - 1) [Laurence, C. R. Co., Inc.](#)
 3. Finish: Clear bright anodized.
- B. Mirror Bottom Clips: As indicated.
- C. Mirror Top Clips: As indicated.
- D. Plated Steel Hardware: Formed-steel shapes with plated finish indicated.
 1. Profile: As indicated.
- E. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.
- F. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

2.5 FABRICATION

- A. Fabricate mirrors in the shop to greatest extent possible.
- B. Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.
- C. Mirror Edge Treatment: Flat polished.

1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
 2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.
- D. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint as recommended in writing by film-backing manufacturer to produce a surface free of bubbles, blisters, and other imperfections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.
- B. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

- A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

3.3 INSTALLATION

- A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
- B. Provide a minimum air space of **1/8 inch (3 mm)** between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
- C. Wall-Mounted Mirrors: Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
 1. Aluminum J-Channels and Cleat: Fasten J-channel directly to wall and attach top trim to continuous cleat fastened directly to wall.
 2. Mirror Clips: Place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges. Locate clips so they are symmetrically placed and evenly spaced.
 3. Install mastic as follows:
 - a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
 - b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
 - c. After mastic is applied, align mirrors and press into place while maintaining a minimum air space of **1/8 inch (3 mm)** between back of mirrors and mounting surface.

3.4 CLEANING AND PROTECTION

- A. Protect mirrors from breakage and contaminating substances resulting from construction operations.
- B. Do not permit edges of mirrors to be exposed to standing water.
- C. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.
- D. Wash exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash mirrors as recommended in writing by mirror manufacturer.

END OF SECTION

SECTION 08 9119

FIXED LOUVERS

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. Fixed, extruded-aluminum louvers.

1.3 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axes of the blades are horizontal).
- C. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
 - 1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
 - 2. Show mullion profiles and locations.
- C. Samples: For each type of metal finish required.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
 - 1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
- B. Seismic Performance: Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. Component Importance Factor: 1.5.
- C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- E. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

- A. Wind-Driven Rain Resistant Louver:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide EME 520DD by Ruskin Company or comparable product by one of the following:
 - a. Airolite Company, LLC (The).
 - b. American Warming and Ventilating, Inc.; a Mestak company.
 - c. Construction Specialties, Inc.
 - d. Industrial Louvers, Inc.
 - e. Reliable Products, Inc.
- B. Fabrication: Extruded Aluminum stationary horizontal chevron louver style.
 - 1. Design: Double drainable blades shall be contained within the frame with double downspouts in jambs and mullions. Louver design shall limit span between visible mullions to 120 inches (3048 mm).
 - 2. Frame:

- a. Frame Depth: 5 inches (127 mm).
- b. Wall Thickness: 0.081 inch (2.1 mm), nominal.
- c. Material: Extruded aluminum, Alloy 6063-T6.
3. Blades:
 - a. Style: Sightproof, double drainable, horizontally mounted on 2 inches (51 mm) centers, nominal.
 - b. Material: Extruded aluminum, Alloy 6063-T6.
 - c. Wall Thickness: 0.063 inch (1.6 mm), nominal.
4. Minimum assembly size: 12 inches wide by 12 inches high (305 mm x 305 mm).
5. Recycled Content: 18% post-consumer. 55% pre-consumer, post-industrial, total 73% by weight.

C. Performance Data:

1. Based on testing 48 inch x 48 inch (1,219 mm x 1,219 mm) size unit in accordance with AMCA 500-L.
2. Free Area: 44 percent, nominal.
3. Free Area Size: 6.99 square feet (0.65 m²).
4. Maximum Recommended Air Flow through Free Area: 1,361 fpm (6.9 m/s).
5. Air Flow: 9514 cfm (4.49 m³/s).
6. Maximum Pressure Drop (at 1361 feet per minute): 0.20 inches w.g. (0.05 kPa).

D. Wind Driven Water Penetration Performance:

1. Based on testing 39 inch x 39 inch (1m x 1m) core area, 41 inch x 44 inch (1.04m x 1.12m) nominal size unit in accordance with AMCA 500-L.
2. Wind Velocity: 29 mph (47 kph).
 - a. Rainfall Rate: 3 inches/hour (76 mm/hour).
 - b. Free Area Velocity: 1361 feet per minute (6.9 m/s).
 - c. Water Resistance Effectiveness: 99.7% (AMCA Class A).
3. Wind Velocity: 50 mph (80 kph).
 - a. Rainfall Rate: 8 inches/hour (203 mm/hour).
 - b. Free Area Velocity: 778 feet per minute (4.0 m/s).
 - c. Water Resistance Effectiveness: 99.0% (AMCA Class A).
4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Bird screening except where insect screening is indicated.

B. Secure screen frames to louver frames with machine screws with heads finished to match louver, spaced a maximum of **6 inches (150 mm)** from each corner and at **12 inches (300 mm)** o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same type and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
2. Finish: Mill finish unless otherwise indicated.
3. Type: Non-rewirable, U-shaped frames.

2.5 MATERIALS

A. Aluminum Extrusions: **ASTM B 221 (ASTM B 221M)**, Alloy 6063-T5, T-52, or T6.

- B. Aluminum Sheet: **ASTM B 209 (ASTM B 209M)**, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
 - 1. Use tamper-resistant screws for exposed fasteners unless otherwise indicated.
 - 2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
 - 3. For color-finished louvers, use fasteners with heads that match color of louvers.
- D. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.6 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
 - 1. Frame Type: Channel unless otherwise indicated.
- C. Include supports, anchorages, and accessories required for complete assembly.
- D. Provide subsills made of same material as louvers.
- E. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.7 ALUMINUM FINISHES

- A. Finish louvers after assembly.
- B. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent 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.
 - 1. Color and Gloss: Match Architect's sample.
 - 2. Louvers to match adjacent surfaces – assume 5 colors total.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and openings, 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. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 9200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

SECTION 09 2116

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: Gypsum board shaft wall assemblies.

1.3 ACTION SUBMITTALS

- A. Product Data: For each component of gypsum board shaft wall assembly.

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For shaft wall assemblies and firestop tracks, from ICC-ES.

1.5 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.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or with gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install interior products 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 E 119 by an independent testing agency.

- B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.
- C. Recycled Content of Gypsum Panel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent by weight.
- D. Regional Materials: Gypsum panel products shall be manufactured within **500 miles (800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles (800 km)** of Project site.

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

- A. Fire-Resistance Rating: As indicated.
- B. STC Rating: As indicated.
- C. Gypsum Shaftliner Board:
 - 1. Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with paper faces.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) American Gypsum.
 - 2) CertainTeed Corporation.
 - 3) Continental Building Products, LLC.
 - 4) Georgia-Pacific Building Products.
 - 5) National Gypsum Company.
 - 6) PABCO Gypsum.
 - 7) United States Gypsum Company.
- D. Non-Load-Bearing Steel Framing, General: Complying with ASTM C 645 requirements for metal unless otherwise indicated and complying with requirements for fire-resistance-rated assembly indicated.
 - 1. Protective Coating: Coating with equivalent corrosion resistance of ASTM A 653/A 653M, **G40 (Z120)** unless otherwise indicated.
- E. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.
 - 1. Depth: As indicated.
 - 2. Minimum Base-Metal Thickness **0.033 inch (0.84 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.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Blazeframe Industries.
 - b. CEMCO; California Expanded Metal Products Co.
 - c. Fire Trak Corp.

- d. GCP Applied Technologies Inc. (formerly Grace Construction Products).
- e. Metal-Lite.
- f. Steel Network, Inc. (The).

- H. Elevator Hoistway Entrances: Manufacturer's standard J-profile jamb strut with long-leg length of **3 inches (76 mm)**, matching studs in depth, and not less than **0.033 inch (0.84 mm)** thick.
- I. Room-Side Finish: Gypsum board.
- J. Shaft-Side Finish: As indicated by fire-resistance-rated assembly design designation.
- K. Insulation: Sound attenuation blankets.

2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with manufacturer's written recommendations.
- B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in Section 09 2900 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written recommendations for application indicated.
- C. Steel Drill Screws: ASTM C 1002 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 capability to sustain, without failure, a load equal to 5 times design load, as determined by testing according to ASTM E 488 conducted by a qualified testing agency.
 - 2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing according to ASTM E 1190 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: As specified in Section 09 2900 "Gypsum Board."
- G. Gypsum Board Cants:
 - 1. Gypsum Board Panels: As specified in Section 09 2900 "Gypsum Board," Type X, **1/2- or 5/8-inch (13- or 16-mm)** panels.
 - 2. Adhesive: Laminating adhesive as specified in Section 09 2900 "Gypsum Board."
 - 3. Non-Load-Bearing Steel Framing: As specified in Section 09 2216 "Non-Structural Metal Framing."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to which gypsum board shaft wall assemblies attach or abut, with Installer present, including hollow-metal frames, elevator hoistway door frames, cast-in anchors, and

structural framing. Examine for compliance with requirements for installation tolerances and other conditions affecting performance.

- 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 PREPARATION

- A. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft wall assemblies to comply with requirements specified in Section 07 8100 "Applied Fireproofing."
- B. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.3 INSTALLATION

- A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and ASTM C 754 other than stud-spacing requirements.
- 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.
 - 1. Elevator Hoistway: At elevator hoistway-entrance door frames, provide jamb struts on each side of door frame.
 - 2. Reinforcing: Where handrails directly attach to gypsum board shaft wall assemblies, provide galvanized steel reinforcing strip with 0.033-inch (0.84-mm) minimum thickness of base metal (uncoated), accurately positioned and secured behind at least one layer of face panel.
- 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, elevator 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. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect while maintaining fire-resistance rating of gypsum board shaft wall assemblies.

- H. 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.
- I. Cant Panels: At projections into shaft exceeding 4 inches (102 mm), install 1/2- or 5/8-inch- (13- or 16-mm-) thick gypsum board cants covering tops of projections.
 - 1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches (610 mm) o.c. with screws fastened to shaft wall framing.
 - 2. Where steel framing is required to support gypsum board cants, install framing at 24 inches (610 mm) o.c. and extend studs from the projection to shaft wall framing.
- J. 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.

3.4 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

SECTION 09 2216

NON-STRUCTURAL METAL FRAMING

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. Non-load-bearing steel framing systems for interior gypsum board assemblies.
 - 2. Suspension systems for interior ceilings and soffits.
 - 3. Grid suspension systems for gypsum board ceilings.
- B. Related Requirements:
 - 1. Section 05 4000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; roof rafters and ceiling joists; and roof trusses.

1.3 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.
- B. Evaluation Reports: For embossed 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.

1.5 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.

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 E 119 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 E 90 and classified according to ASTM E 413 by an independent testing agency.
- C. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 10 lbf/sq. ft. (480 Pa).

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 C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 - 2. Protective Coating: ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.
- C. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [ClarkDietrich Building Systems](#).
 - b. [MarinoWARE](#).
 - c. [MRI Steel Framing, LLC](#).
 - d. [SCAFCO Steel Stud Company](#).
 - 2. Minimum Base-Metal Thickness: 0.0329 inch (0.836 mm).
 - 3. Depth: As indicated on Drawings.
- D. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [ClarkDietrich Building Systems](#).
 - b. [MarinoWARE](#).
 - c. [MRI Steel Framing, LLC](#).
 - d. [SCAFCO Steel Stud Company](#).
 - 2. Configuration: Asymmetrical or hat shaped.
- E. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
 - 1. Depth: As indicated on Drawings.
 - 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 A 641/A 641M, 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.

- F. Z-Shaped Furring: With slotted or nonslotted web, face flange of **1-1/4 inches (32 mm)**, wall attachment flange of **7/8 inch (22 mm)**, minimum uncoated-metal thickness of **0.0179 inch (0.455 mm)**, and depth required to fit insulation thickness indicated.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [ClarkDietrich Building Systems](#).
 - b. [MarinoWARE](#).
 - c. [MRI Steel Framing, LLC](#).
 - d. [SCAFCO Steel Stud Company](#).

2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, 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. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 AC193 AC58 or AC308 as appropriate for the substrate.
 - a. Uses: Securing hangers to structure.
 - b. Type: Torque-controlled, expansion anchor torque-controlled, adhesive anchor or adhesive anchor.
 - c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or **ASTM F 1941 (ASTM F 1941M)**, Class Fe/Zn 5, unless otherwise indicated.
 - d. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group **1 (A1)** stainless-steel bolts, **ASTM F 593 (ASTM F 738M)**, and nuts, **ASTM F 594 (ASTM F 836M)**.
 2. Power-Actuated Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, **0.16 inch (4.12 mm)** in diameter.
- D. Flat Hangers: Steel sheet, in size indicated on Drawings.
- E. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-metal thickness of **0.0538 inch (1.367 mm)** and minimum **1/2-inch- (13-mm-)** wide flanges.
1. Depth: As indicated on Drawings.
- 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 C 645.
 - a. Minimum Base-Metal Thickness: **0.0329 inch (0.836 mm)**.
 - b. Depth: As indicated on Drawings.
 3. Embossed Steel Studs and Tracks: ASTM C 645.
 - a. Minimum Base-Metal Thickness: **0.0190 inch (0.483 mm)**.
 - b. Depth: As indicated on Drawings.
 4. Hat-Shaped, Rigid Furring Channels: ASTM C 645, **7/8 inch (22 mm)** deep.
 - a. Minimum Base-Metal Thickness: **0.0329 inch (0.836 mm)**.
 5. Resilient Furring Channels: **1/2-inch- (13-mm-)** deep members designed to reduce sound transmission.
 - a. Configuration: Asymmetrical or hat shaped.

- G. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong World Industries, Inc.
 - b. Chicago Metallic Corporation.
 - c. United States Gypsum Company.

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. Fasteners for Metal 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 one of the following:
 - 1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
 - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, **1/8 inch** 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.
- B. Coordination with Sprayed Fire-Resistive Materials:
 - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than **24 inches** o.c.
 - 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.

1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 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** o.c. unless otherwise indicated.
 2. Multilayer Application: **16 inches** o.c. unless otherwise indicated.
 3. Tile Backing Panels: **16 inches** 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 (runners) 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 penetrating 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 runner 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. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced **24 inches** o.c.
- F. Z-Shaped Furring Members:
 1. Erect insulation, specified in Section 07 2100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced **24 inches (610 mm)** o.c.
 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced **24 inches (610 mm)** o.c.
 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than **12 inches (305 mm)** from corner and cut insulation to fit.
- G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than **1/8 inch** 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): **24 inches (610 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. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- F. 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.
- G. 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.

END OF SECTION

SECTION 09 2900

GYPSUM BOARD

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. Interior gypsum board.
 - 2. Tile backing panels.
- B. Related Requirements:
 - 1. Section 06 1600 "Sheathing" for gypsum sheathing for exterior walls.
 - 2. Section 09 2216 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.
 - 3. Section 09 2116.23 "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.

1.3 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 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. **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.
- C. Samples: For the following products:
 - 1. Trim Accessories: Full-size Sample in **12-inch- (300-mm-)** long length for each trim accessory indicated.

1.4 QUALITY ASSURANCE

- A. Mockups: Before beginning gypsum board installation, install mockups of at least **100 sq. ft. (9 sq. m)** in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Install mockups for the following:
 - a. Each level of gypsum board finish indicated for use in exposed locations.
 - 2. Apply or install final decoration indicated, including painting, on exposed surfaces for review of mockups.

3. Simulate finished lighting conditions for review of mockups.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 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.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, 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, those that are moisture damaged, and those that are 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 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 E 119 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 E 90 and classified according to ASTM E 413 by an independent testing agency.
- C. Environmental Certification: Provide materials carrying certification by one of the following:
 1. Greenguard Gold Certification
 2. UL Environment ISR 100

2.2 GYPSUM BOARD, GENERAL

- A. Recycled Content of Gypsum Panel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Regional Materials: Gypsum panel products shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) 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.

2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Wallboard: ASTM C 1396/C 1396M.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [CertainTeed Corp](#) Air Renew Gypsum Board and Gypsum Board
 - b. [Georgia-Pacific Gypsum LLC](#) ToughRock MH Gypsum Wallboard and DensArmor Plus® High-Performance Interior Panels
 - c. [Lafarge North America Inc](#) Gypsum Panels
 - d. [National Gypsum Company](#) Gold Bond Gypsum Board
 - e. [USG Corporation](#) Sheetrock and FiberRock
 - f. American Gypsum Eagleroc
- B. Gypsum Board, Type X: ASTM C 1396/C 1396M.
1. Thickness: **5/8 inch (15.9 mm)**.
 2. Long Edges: Tapered.
- C. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
1. Thickness: **1/2 inch (12.7 mm)**.
 2. Long Edges: Tapered.
- D. Abuse-Resistant Gypsum Board: ASTM C 1396/C 1396M gypsum board, tested according to ASTM C 1629/C 1629M.
1. Core: **5/8 inch (15.9 mm)**, Type X.
 2. Surface Abrasion: ASTM C 1629/C 1629M, meets or exceeds Level 2 requirements.
 3. Indentation: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements.
 4. Soft-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements.
 5. Long Edges: Tapered.
 6. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- E. Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
1. Core: **5/8 inch (15.9 mm)**, Type X.
 2. Long Edges: Tapered.
 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or 1325, with manufacturer's standard edges.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [CertainTeed Corp.](#); FiberCement Underlayment or BackerBoard.
 - b. [National Gypsum Company, Permabase Cement Board.](#)
 - c. [USG Corporation; DUROCK Cement Board.](#)
 2. Thickness: **5/8 inch (15.9 mm)**.
 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.5 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc or Paper-faced galvanized steel sheet.

2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.
- B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Fry Reglet Corp.](#)
 - b. [Gordon, Inc.](#)
 - c. [Pittcon Industries.](#)
 2. Aluminum: Alloy and temper with not less than the strength and durability properties of **ASTM B 221 (ASTM B 221M)**, Alloy 6063-T5.
 3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.6 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- 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 setting-type taping compound.
 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 or high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.
- D. Joint Compound for Tile Backing Panels:
 1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.7 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
 1. Laminating adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from **0.033 to 0.112 inch (0.84 to 2.84 mm)** thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound Attenuation Blankets: ASTM C 665, 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 of Blankets: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- E. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Accumetric LLC; BOSS 824 Acoustical Sound Sealant.](#)
 - b. [Grabber Construction Products; Acoustical Sealant GSC.](#)
 - c. [Pecora Corporation; AC-20 FTR or AIS-919.](#)
 - d. [Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.](#)
 - e. [USG Corporation; SHEETROCK Acoustical Sealant.](#)
 - 2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Thermal Insulation: As specified in Section 07 2100 "Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.
- 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 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- 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 (1.5 mm)** 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. (0.7 sq. m)** 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- (6.4- to 9.5-mm-)** wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide **1/4- to 1/2-inch- (6.4- to 12.7-mm-)** 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 C 919 and with manufacturer's written recommendations 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 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Wallboard Type: Vertical surfaces unless otherwise indicated.
 - 2. Type X: Vertical surfaces unless otherwise indicated.
 - 3. Ceiling Type: Ceiling surfaces.
 - 4. Abuse-Resistant Type: As indicated on Drawings.
 - 5. Mold-Resistant Type: As indicated on Drawings.
- 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-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 (400 mm)** 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-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 and face layers separately to supports with screws.

- 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 recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 APPLYING TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLING 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 C 840 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. Bullnose Bead: Use where indicated.
 3. LC-Bead: Use at exposed panel edges.
 4. L-Bead: Use where indicated.
 5. U-Bead: Use where indicated.
 6. Curved-Edge Cornerbead: Use at curved openings.
- D. Aluminum Trim: Install in locations indicated on Drawings.

3.6 FINISHING 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, rounded or beveled edges, 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 C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: Panels that are substrate for tile.
 - 1. Level 3: Where indicated on Drawings.
 - 2. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 09 9123 "Interior Painting."
 - 3. Level 5: Where indicated on Drawings.
 - a. Primer and its application to surfaces are specified in Section 09 9123 "Interior Painting."
 - b. Level 5 Finish : SHEETROCK Brand *Tuff-Hide* spray applied primer/skim coat: At corridors and stairwells, and where indicated
 - 4. Where Level 5 gypsum board finish is indicated, embed tape in joint compound and apply first, fill (second), and finish (third) coats of joint compound over joints, angles, fastener heads, and accessories; and apply a thin, uniform skim coat of joint compound over entire surface. For skim coat, use joint compound specified for third coat, or a product specially formulated for this purpose and acceptable to gypsum board manufacturer. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects, tool marks, and ridges and ready for decoration.
 - 5. For Level 4 gypsum board finish, embed tape in joint compound and apply first, fill (second), and finish (third) coats of joint compound over joints, angles, fastener heads, and accessories. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects and ready for decoration.
 - 6. For Level 1 gypsum board finish, embed tape at joints in ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
- E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Before Contractor installs gypsum board ceilings, Architect will conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
 - 1. Notify Architect seven days in advance of date and time when Project, or part of Project, will be ready for above-ceiling observation.

3.8 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

SECTION 09 3000

TILING

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. Ceramic tile.
 - 2. Porcelain Tile.
 - 3. Stone thresholds.
 - 4. Waterproof membrane for thin-set tile applications.
 - 5. Crack isolation membrane for thin-set tile applications.
- B. Related Sections:
 - 1. Section 07 9200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
 - 2. Section 09 2900 "Gypsum Board" for cementitious backer units.

1.3 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in "American National Standard Specifications for Installation of Ceramic Tile."
- C. Module Size: Actual tile size plus joint width indicated.
- D. Face Size: Actual tile size, excluding spacer lugs.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.5 PERFORMANCE REQUIREMENTS

- A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:
 - 1. Level Surfaces: Minimum 0.6.
 - 2. Step Treads: Minimum 0.6.
 - 3. Ramp Surfaces: Minimum 0.8.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Sustainable Design Submittals:
 - 1. [Product Data](#): For adhesives, indicating VOC content.
- C. 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.
- D. Samples for Initial Selection: For each type of tile and grout indicated. Include Samples of accessories involving color selection.
- E. Samples for Verification:
 - 1. Full-size units of each type and composition of tile and for each color and finish required.
 - 2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least **12 inches (300 mm)** square, but not fewer than 4 tiles. Use grout of type and in color or colors approved for completed Work.
 - 3. Full-size units of each type of trim and accessory for each color and finish required.
 - 4. Stone thresholds in **6-inch (150-mm)** lengths.
 - 5. Metal edge strips in **6-inch (150-mm)** lengths.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Certificates: For each type of product, signed by product manufacturer.
- D. Material Test Reports: For each tile-setting and -grouting product.

1.8 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 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
 - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer is a five-star member of the National Tile Contractors Association.
 - 2. Installer's supervisor for Project holds the International Masonry Institute's Foreman Certification.
 - 3. Installer employs Ceramic Tile Education Foundation Certified Installers or installers recognized by the U.S. Department of Labor as Journeyman Tile Layers.

- 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 each type of floor tile installation.
 - 2. Build mockup of each type of wall tile installation.
 - 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 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.
- E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.11 PROJECT 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 one 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 one manufacturer and each aggregate from one source or producer.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:
 - 1. Stone thresholds.
 - 2. Waterproof membrane.
 - 3. Crack isolation membrane.
 - 4. Joint sealants.
 - 5. Cementitious backer units.
 - 6. Metal edge strips.

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements unless otherwise indicated.
- B. ANSI Glass Tile Standard: Provide glass tile that complies with ANSI A137.2 for types and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements unless otherwise indicated.
- C. 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 TCA installation methods specified in tile installation schedules, and other requirements specified.
- D. FloorScore Compliance: Tile for floors shall comply with requirements of FloorScore Standard.
- E. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- F. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.3 TILE PRODUCTS

- A. Tile Type: Porcelain paver tile.
 - 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. [Crossville, Inc.](#)
 - b. [Daltile; Division of Dal-Tile International Inc.](#)
 - c. Stonepeak
 - 2. Composition: Porcelain.
 - 3. Face Size: 6 x 36 inches, 12 x 24 inches
 - 4. Colors: 3 colors total.
- B. Tile Type: Glazed wall tile.
 - 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. [Crossville, Inc.](#)
 - b. [Daltile; Division of Dal-Tile International Inc.](#)
 - c. Stonepeak
 - 2. Composition: Ceramic.
 - 3. Module Size: 4 x 16 inches.
 - 4. Finish: white polished.
- C. Mosaic Wall tile:
 - 1. Basis of Design: see finish schedule for product selections.
 - 2. Composition: Porcelain
 - 3. Module Size: 1 X 1 inch
- D. Mosaic Wall tile:
 - 1. Basis of Design: see finish schedule for product selections.
 - 2. Composition: Glass

3. Module Size: 1 X 1 inch

- E. Tile Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
1. Base Cove: as indicated on drawings.
 2. External Corners for Thin-Set Mortar Installations: Surface bullnose, module size same as adjoining flat tile.
 3. Internal Corners: Field-buttet square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.
 4. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from **1/2 to 1/4 inch (12.7 to 6.35 mm)** across nominal **4-inch (100-mm)** dimension.

2.4 THRESHOLDS

- A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to **1/16 inch (1.5 mm)** above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to **1/2 inch (12.7 mm)** or less above adjacent floor surface.
- B. Marble Thresholds: ASTM C 503, with a minimum abrasion resistance of 10 per ASTM C 1353 or ASTM C 241 and with honed finish.
1. Description: Uniform, fine- to medium-grained white stone with gray veining.

2.5 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. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; **0.008-inch (0.203-mm)** nominal thickness.
1. **Products:** Subject to compliance with requirements, provide the following:
 - a. **Schluter Systems L.P.; KERDI.**

2.6 CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Corrugated Polyethylene: Corrugated polyethylene with dovetail-shaped corrugations and with anchoring webbing on the underside; **3/16-inch (4-mm)** nominal thickness.
1. **Products:** Subject to compliance with requirements, provide the following:
 - a. **Schluter Systems L.P.; DITRA.**

2.7 SETTING MATERIALS

- A. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide products by Custom Building Products or comparable product by one of the following:
 - a. [ARDEX Americas.](#)
 - b. [LATICRETE SUPERCAP, LLC.](#)
 - c. [MAPEI Corporation.](#)
2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.8 GROUT MATERIALS

- A. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.
- B. Standard Cement Grout: ANSI A118.6.
 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide products by Custom Building Products or comparable product by one of the following:
 - a. [ARDEX Americas.](#)
 - b. [LATICRETE SUPERCAP, LLC.](#)
 - c. [MAPEI Corporation.](#)
- C. Polymer-Modified Tile Grout: ANSI A118.7.
 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide products by Custom Building Products or comparable product by one of the following:
 - a. [ARDEX Americas.](#)
 - b. [LATICRETE SUPERCAP, LLC.](#)
 - c. [MAPEI Corporation.](#)
 2. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.

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. Temporary Protective Coating: Product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.
 1. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.
- C. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; white zinc alloy or stainless-steel, ASTM A 666, 300 Series exposed-edge material.
 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Blanke Corporation.](#)
 - b. [Ceramic Tool Company, Inc.](#)
 - c. [Schluter Systems L.P.](#)

- D. 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.
- E. Floor Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bonsal American, an Oldcastle company.
 - b. Custom Building Products.
 - c. Jamo Inc.
 - d. Southern Grouts & Mortars, Inc.
 - e. Summitville Tiles, Inc.

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 installed tile.
 - 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 thin-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 - 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 - 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- 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 thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

- B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped **1/4 inch per foot (1:50)** toward drains.
- C. 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.
- D. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.3 TILE INSTALLATION

- A. Comply with TCA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCA 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 TCA 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 composed of tiles **8 by 8 inches (200 by 200 mm)** or larger.
 - c. Tile floors composed of rib-backed tiles.
- 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. 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.
 - 1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
 - 2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 - 3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Paver Tile: **1/4 inch (6.4 mm)**.
 - 2. Glazed Wall Tile: **1/16 inch (1.6 mm)**.
 - 3. Porcelain Tile: **1/4 inch (6.4 mm)**.
- G. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

- H. 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.
 - 2. Prepare joints and apply sealants to comply with requirements in Section 07 9200 "Joint Sealants."
- I. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
 - 1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in latex-portland cement mortar (thin set).
 - 2. Do not extend waterproofing or crack isolation membrane under thresholds set in latex-portland cement mortar. Fill joints between such thresholds and adjoining tile set on waterproofing or crack isolation membrane with elastomeric sealant.
- J. Metal Edge Strips: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated.
- K. Floor Sealer: Apply floor sealer to grout joints in tile floors according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 TILE BACKING PANEL INSTALLATION

- A. Install cementitious backer units and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use latex-portland cement mortar for bonding material unless otherwise directed in manufacturer's written instructions.

3.5 WATERPROOFING INSTALLATION

- A. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness and bonded securely to substrate.
- B. Do not install tile or setting materials over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

3.6 CRACK ISOLATION MEMBRANE INSTALLATION

- A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.
- B. Do not install tile or setting materials over crack isolation membrane until membrane has cured.

3.7 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove grout residue from tile as soon as possible.

2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.8 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.9 INTERIOR TILE INSTALLATION SCHEDULE

- A. Interior Floors on Concrete:
 1. F122: Thin-set mortar on waterproof membrane.
 - a. Mortar: Latex- portland cement mortar.
 - b. Grout: Polymer-modified grout.
- B. Interior Walls, Metal Studs or Furring:
 1. W244: Thin-set mortar on cementitious backer units.
 - a. Mortar: Latex- portland cement mortar.
 - b. Grout: Polymer-modified grout.

END OF SECTION

SECTION 09 5113

ACOUSTICAL PANEL CEILINGS

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 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.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 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.
- C. Samples: For each exposed product and for each color and texture specified, **6 inches (150 mm)** in size.

1.5 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 (1:48)**.

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 and anchor and fastener type, from ICC-ES.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.7 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. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
- 2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.

1.8 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

- 1. Build mockup of typical ceiling area.
- 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.
- 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 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.

1.10 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. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class A according to ASTM E 1264.
 - 2. Smoke-Developed Index: 50 or less.

2.3 ACOUSTICAL PANELS, GENERAL

- A. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.
- B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- C. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.
- D. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface according to ASTM E 795.
- E. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

2.4 ACOUSTICAL PANELS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide one of the following:
 - 1. [Armstrong World Industries, Inc.](#) Cirrus No. 589
 - 2. [CertainTeed Corp.](#) Cashmere CM-450
 - 3. [USG Interiors, Inc.; Subsidiary of USG Corporation.](#) Eclipse Clima Plus 76975
- B. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
 - 1. Type and Form: Type III, mineral base with painted finish; Form 2, water felted.
 - 2. Pattern: CE (perforated, small holes and lightly textured).
- C. Color: White
- D. LR: Not less than 0.85.

- E. NRC: Not less than 0.50.
- F. CAC: Not less than 30.
- G. Edge/Joint Detail: Reveal sized to fit flange of exposed suspension system members.
- H. Thickness: 5/8 inch (15 mm)
- I. Modular Size: 24 by 24 inches (610 by 1220 mm)

2.5 ACOUSTICAL PANELS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide one of the following:
 - 1. [Armstrong World Industries, Inc.](#) Optima #3251
 - 2. [CertainTeed Corp.](#) Symphony f – White Overtone
 - 3. [USG Interiors, Inc.; Subsidiary of USG Corporation.](#) Halcyon
- B. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
 - 1. Type and Form: Type XII, glass-fiber base with membrane-faced overlay; Form 2, cloth.
 - 1. Pattern: E (lightly textured)
- C. Color: White.
- D. LR: 0.95
- E. NRC: 0.90
- F. AC: 190
- G. Edge/Joint Detail: Reveal sized to fit flange of exposed suspension system members.
- H. Thickness: 1 inch
- I. Modular Size: 30 by 60 inches.

2.6 METAL SUSPENSION SYSTEM

- A. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C 635/C 635M 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 C 635/C 635M.
- B. [Recycled Content](#): Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- C. 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 \(Z90\)](#) coating designation; with prefinished [15/16-inch- \(24-mm-\)](#) 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 in color as selected from manufacturer's full range.
- D. 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 (Z90) coating designation; with prefinished 9/16-inch- (15-mm-) 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 in color as selected from manufacturer's full range.

2.7 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated.
1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488/E 488M or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: Postinstalled bonded anchors.
 - b. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316.
 2. 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 hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.106-inch- (2.69-mm-) diameter wire.
- C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- D. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1-mm-) thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.
- E. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches (610 mm) o.c. on all cross tees.

2.8 METAL EDGE MOLDINGS AND TRIM

- A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations; 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.

B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips.

1. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
2. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.9 ACOUSTICAL SEALANT

A. Products: Subject to compliance with requirements, provide one of the following:

1. Acoustical Sealant for Exposed and Concealed Joints:
 - a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
 - b. USG Corporation; SHEETROCK Acoustical Sealant.
2. Acoustical Sealant for Concealed Joints:
 - a. Henkel Corporation; OSI Pro-Series SC-175 Acoustical Sound Sealant.
 - b. Pecora Corporation; AIS-919.
 - c. Tremco, Inc.; Tremco Acoustical Sealant.

B. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant.
2. Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant.
3. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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 C 636/C 636M 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 (1200 mm)** o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than **8 inches (200 mm)** from ends of each member.
 - 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. 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 (400 mm)** o.c. and not more than **3 inches (75 mm)** from ends. Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. 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.

3.4 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of **1/8 inch in 12 feet (3 mm in 3.6 m)**, 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 (3 mm in 3.6 m)**, non-cumulative.

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

SECTION 09 6229

CORK FLOORING

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. Cork floor tile.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of cork flooring.
 - 1. Include cork flooring layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 2. Show details of special patterns.
- C. Samples for Initial Selection: For each type of cork flooring indicated.
- D. Samples for Verification: Full-size units of each type, color, pattern, and finish of cork flooring required.
- E. Product Schedule: For cork flooring. Use same designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of cork flooring to include in maintenance manuals.

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. Cork Flooring: Furnish one box for every 50 boxes or fraction thereof, of each type, color, pattern, and finish of cork flooring installed.

1.6 QUALITY ASSURANCE

- A. Mockups: Match existing floor in the Chapel. Architect and Owner approval required

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store cork 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 (10 deg C) or more than 90 deg F (32 deg C). Store cork flooring on flat surfaces.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 65 deg F (18 deg C) or more than 75 deg F (24 deg C) where relative humidity is between 45 and 65 percent, in spaces to receive cork flooring during the following periods:
 - 1. 72 hours before installation.
 - 2. During installation.
 - 3. 72 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 65 deg F (18 deg C) or more than 75 deg F (24 deg C).
- C. Close spaces to traffic during cork flooring installation.
- D. Close spaces to traffic for 72 hours after cork flooring installation.
- E. Install cork flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For cork flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 CORK FLOOR TILE

- A. Basis of Design: Subject to compliance with requirements, provide [Heirloom Plank cork flooring by Expanko Inc.](#), or a comparable product by one of the following:
 - 1. [Cork Direct.](#)
 - 2. [Gerbert Limited.](#)
 - 3. [Globus Cork.](#)
 - 4. [Jelinek Cork Group.](#)
 - 5. [Nova Distinctive Floors.](#)
 - 6. [USFloors Inc.](#)
- B. Composition: 100 percent natural cork bark and recycled cork granules and set in a natural or synthetic, flexible resin matrix; homogeneous and uniform in composition throughout the tile thickness.
- C. Nominal Density: Manufacturer's standard.
- D. Nominal Thickness: 1/2 inch (12 mm).
- E. Nominal Size: Match existing.

- F. Color: Match existing.
- G. Factory Finish: water-based matte polyurethane.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by cork flooring manufacturer for applications indicated.
- B. Vapor Retarder: ASTM D 4397, polyethylene sheet not less than **6.0 mils (0.15 mm)** thick.
- C. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit cork flooring and substrate conditions indicated.

2.4 FIELD-APPLIED FINISHES

- A. Sealer: Product as recommended by cork flooring manufacturer.
- B. Finish Coatings: Products as recommended by cork flooring manufacturer.

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 cork flooring.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to cork flooring manufacturer's written instructions to ensure adhesion of cork flooring.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 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 cork flooring manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by cork 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 **200 sq. ft. (18.6 sq. m)**, and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of **3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m)** in 24 hours.

- b. 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.
- 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 cork flooring until materials are the same temperature as space where they are to be installed.
 - 1. At least 72 hours in advance of installation, move cork flooring products and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by cork flooring.

3.3 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing cork flooring.
- B. Mix together floor tiles from each carton to ensure uniform distribution of shade.
- C. Discard broken, cracked, chipped, or deformed floor tiles.
- D. Lay out floor tiles 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.
- E. Lay floor tiles square with room axis in pattern indicated.
- F. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- G. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- H. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- I. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of appearance between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- J. Adhere floor tiles 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 FIELD-APPLIED FINISHES

- A. Apply finishes according to cork flooring manufacturer's written instructions.
- B. Finish Coatings: Apply two coat(s).

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting cork flooring.
- B. Perform the following operations immediately after completing cork flooring installation:
 - 1. Remove blemishes from surfaces.
 - a. Remove installation adhesive from surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect cork flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover cork flooring until Substantial Completion.

END OF SECTION

SECTION 09 6513

RESILIENT BASE AND ACCESSORIES

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. Resilient base.
 - 2. Resilient stair accessories.
 - 3. Resilient molding accessories.

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. Product Data: For sealants, indicating VOC content.
- C. Samples: For each exposed product and for each color and texture specified, not less than **12 inches (300 mm)** long.
- D. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

1.4 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. Furnish not less than **10 linear feet (3 linear m)** for every **500 linear feet (150 linear m)** or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Coordinate mockups in this Section with mockups specified in other Sections.
 - 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.
 - 3. 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. Store resilient products 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 (10 deg C)** or more than **90 deg F (32 deg C)**.

1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than **70 deg F (21 deg C)** or more than **95 deg F (35 deg C)**, in spaces to receive resilient products 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 (13 deg C)** or more than **95 deg F (35 deg C)**.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 RESILIENT BASE

- A. Resilient Base:
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Armstrong World Industries, Inc.](#)
 - b. [Burke Mercer Flooring Products; Division of Burke Industries, Inc.](#)
 - c. [Flexco, Inc.](#)
 - d. [Johnsonite.](#)
 - e. [Roppe Corporation, USA.](#)
- B. Resilient Base Standard: ASTM F 1861 Type TS (rubber, vulcanized thermoset) or ASTM F 1861 Type TP (rubber, thermoplastic).
 - 1. Manufacturing Method: Group I (solid, homogeneous) or Group II (layered).
 - 2. Style A, Straight: Provide in areas with carpet.
 - 3. Style B, Cove: Provide in areas with resilient floor coverings.
- C. Thickness: **0.125 inch (3.2 mm)**.
- D. Height: **4 inches (102 mm)**.
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Job formed.
- G. Inside Corners: Job formed.
- H. Colors: As indicated in Finish Schedule, A9.30.

2.2 RUBBER MOLDING ACCESSORY

- A. Description:
 - 1. Cap for cove carpet.
 - 2. Cap for cove resilient flooring.
 - 3. Carpet bar for tackless installations.
 - 4. Carpet edge for glue-down applications.
 - 5. Nosing for carpet.
 - 6. Joiner for tile and carpet.
 - 7. Transition strips.
- B. Profile and Dimensions: As indicated.
- C. Locations: Provide rubber molding accessories in areas indicated.
- D. Colors and Patterns: As indicated by manufacturer's designations.

2.3 INSTALLATION MATERIALS

- A. Concrete Slab Primer: Non-staining type as recommended by flooring manufacturer.
- B. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- C. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
 - 1. Adhesives shall have a VOC content of 50 g/L or less.
- D. 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.
- E. Metal Edge Strips: Extruded aluminum with mill finish, nominal **2 inches (50.8 mm)** wide, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.

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 resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

- B. Concrete Substrates for Resilient Accessories: Prepare horizontal surfaces according to ASTM F 710.
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 manufacturer. Do not use solvents.
 3. Alkalinity and Adhesion Testing: Perform tests recommended by 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 9 pH.
 4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (18.6 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - b. 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.
- 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 resilient products 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 products and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 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 (76 mm) 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 (76 mm) in length.

- a. Miter or cope corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. 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.

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 - 1. Remove adhesive and other blemishes from surfaces.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION

SECTION 09 6813

TILE CARPETING

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 modular carpet tile.
- B. Related Requirements:
 - 1. Section 02 4119 "Selective Demolition" for removing existing floor coverings.
 - 2. Section 09 6513 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:
 - a. Review delivery, storage, and handling procedures.
 - b. Review ambient conditions and ventilation procedures.
 - c. Review subfloor preparation procedures.

1.4 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.
- 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. Type of subfloor.
 - 4. Type of installation.
 - 5. Pattern of installation.
 - 6. Pattern type, location, and direction.
 - 7. Pile direction.
 - 8. Type, color, and location of insets and borders.
 - 9. Type, color, and location of edge, transition, and other accessory strips.
 - 10. 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.
 - 2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- (300-mm-) long Samples.
 - E. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
 - F. Sustainable Product Certification: Provide ANSI/NSF 140 certification for carpet products.
- 1.5 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.
- 1.6 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.
- 1.7 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: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd. (8.3 sq. m).
- 1.8 QUALITY ASSURANCE
- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association or can demonstrate compliance with its certification program requirements.
 - B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockups at locations and in sizes shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- 1.9 DELIVERY, STORAGE, AND HANDLING
- A. Comply with CRI's "CRI Carpet Installation Standard."
- 1.10 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.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.11 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: As indicated in Finish Schedule, A9.30
- B. Sustainable Design Requirements:
 - 1. Sustainable Product Certification: Gold level certification according to ANSI/NSF 140.
 - 2. Carpet and cushion shall comply with testing and product requirements of CRI's "Green Label Plus" testing program.

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: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.
 - 1. Adhesives shall have a VOC content of 50 g/L or less.
- C. Metal Edge/Transition Strips: Extruded aluminum with mill finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

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 03 3000 "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. (18.6 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - b. 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.
 - c. 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 (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm) 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: Partial glue down; install periodic tiles with releasable, pressure-sensitive adhesive.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.

- D. Maintain pile-direction patterns recommended in writing by carpet tile manufacturer.
- 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.

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.
- 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

SECTION 09 6816

SHEET CARPETING

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. Tufted carpet.
- B. Related Requirements:
1. Section 02 4119 "Selective Demolition" for removing existing floor coverings.
 2. **[Section 09 6519 Section 09 6513 "Resilient Base and Accessories"**for resilient wall base and accessories installed with carpet.
 3. Section 09 6813 "Tile Carpeting."

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **Project site**.
1. Review methods and procedures related to carpet installation including, but not limited to, the following:
 - a. Review delivery, storage, and handling procedures.
 - b. Review ambient conditions and ventilation procedures.
 - c. Review subfloor preparation procedures.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following, including installation recommendations for each type of substrate:
1. Carpet: For each type indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
- B. LEED Submittals:
1. Product Data for Credit EQ 4.3:
 - a. For carpet, documentation indicating compliance with testing and product requirements of CRI's "Green Label Plus" program.
 - b. For installation adhesive, including printed statement of VOC content.
- C. Shop Drawings: Show the following:
1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
 2. Carpet type, color, and dye lot.
 3. Locations where dye lot changes occur.
 4. Seam locations, types, and methods.
 5. Type of subfloor.
 6. Type of installation.

7. Pattern type, repeat size, location, direction, and starting point.
8. Pile direction.
9. Type, color, and location of insets and borders.
10. Type, color, and location of edge, transition, and other accessory strips.
11. 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: **12-inch-** (300-mm-) square Sample.
2. Exposed Edge, Transition, and Other Accessory Stripping: **12-inch-** (300-mm-) long Samples.
3. Carpet Seam: **6-inch** (150-mm) Sample.
4. Mitered Carpet Border Seam: **12-inch-** (300-mm-) square Sample. Show carpet pattern alignment.

E. Product Schedule: For carpet. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Test Reports: For carpet, for tests performed by a qualified testing agency.
- C. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet to include in maintenance manuals. Include the following:
 1. Methods for maintaining carpet, 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.

1.7 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: Full-width rolls equal to 5 percent of amount installed for each type indicated, but not less than **10 sq. yd.** (8.3 sq. m).

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced Installer who is certified by the International Certified Floorcovering Installers Association at the **[Commercial II]** **[Master II]** <Insert description> certification level.
- B. Fire-Test-Response Ratings: Where indicated, provide carpet identical to those of assemblies tested for fire response per NFPA 253 by a qualified testing agency.
- C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 1. Build mockups at locations and in sizes shown on Drawings.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI's "CRI Carpet Installation Standard."

1.10 FIELD CONDITIONS

- A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.
- C. Do not install carpet over concrete slabs until slabs have cured, are sufficiently dry to bond with adhesive, and have pH range recommended by carpet manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.

1.11 WARRANTY

- A. Special Warranty for Carpet: Manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.
 1. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
 2. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, excess static discharge, and delamination.
 3. Warranty Period: **10** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TUFTED CARPET

- A. Broadloom carpet: As indicated in Finish Schedule, A9.30.
- B. Sustainable Design Requirements:
 1. Sustainable Product Certification: Gold level certification according to ANSI/NSF 140.
 2. Carpet and cushion shall comply with testing and product requirements of CRI's "Green Label Plus" testing program.

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended or provided by carpet manufacturer.
 1. Adhesives shall have a VOC content of 50 g/L or less.

- C. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.
- D. Metal Edge/Transition Strips: Extruded aluminum with [mill] <Insert finish> finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

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 performance. Examine carpet for type, color, pattern, and potential defects.
- B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
 - 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet manufacturer.
 - 2. Subfloor finishes comply with requirements specified in Section 03 3000 "Cast-in-Place Concrete" for slabs receiving carpet.
 - 3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI 104, Section 7.3, "Site Conditions; Floor Preparation," and with carpet manufacturer's written installation instructions for preparing substrates.
- 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 (3 mm)** wide or wider, and protrusions more than **1/32 inch (0.8 mm)**, unless more stringent requirements are required by manufacturer's written instructions.
- C. 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 carpet manufacturer.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

3.3 INSTALLATION

- A. Comply with CRI 104 and carpet manufacturer's written installation instructions for the following:
 - 1. Direct-Glue-Down Installation: Comply with CRI 104, Section 9, "Direct Glue-Down Installation."
- B. Comply with carpet manufacturer's written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.

- C. Do not bridge building expansion joints with carpet.
- D. Cut and fit carpet 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 manufacturer.
- E. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- G. Install pattern parallel to walls and borders to comply with CRI 104, Section 15, "Patterned Carpet Installations" and with carpet manufacturer's written recommendations.

3.4 CLEANING AND PROTECTING

- A. Perform the following operations immediately after installing carpet:
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
 - 2. Remove yarns that protrude from carpet surface.
 - 3. Vacuum carpet using commercial machine with face-beater element.
- B. Protect installed carpet to comply with CRI 104, Section 16, "Protecting Indoor Installations."
- C. Protect carpet 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 manufacturer and carpet adhesive manufacturer.

END OF SECTION

SECTION 09 9113
EXTERIOR PAINTING

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 surface preparation and the application of paint systems on the following exterior substrates:
 - 1. Concrete.
 - 2. Galvanized metal.
- B. Related Requirements:
 - 1. Section 05 1200 "Structural Steel Framing" and Section 05 1213 "Architecturally Exposed Structural Steel Framing" for shop priming of metal substrates.
 - 2. Section 05 5000 "Metal Fabrications" for shop priming metal fabrications.
 - 3. Section 09 9600 "High-Performance Coatings" for tile-like coatings.
 - 4. Section 09 9300 "Staining and Transparent Finishing" for surface preparation and the application of wood stains and transparent finishes on exterior wood substrates.

1.3 DEFINITIONS

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- D. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- E. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- F. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 - 2. Indicate VOC content.
- B. Sustainable Design Submittals:

1. **Product Data:** For paints and coatings, indicating VOC content.
 - C. Samples for Initial Selection: For each type of topcoat product.
 - D. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
 1. Submit Samples on rigid backing, **8 inches (200 mm)** 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.
 - E. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.
- 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. Paint: 5 percent, but not less than **1 gal. (3.8 L)** of each material and color applied.
- 1.6 QUALITY ASSURANCE
- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least **100 sq. ft. (9 sq. m)**.
 - b. Other Items: Architect will designate items or areas required.
 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- 1.7 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 (7 deg C)**.
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.
- 1.8 FIELD CONDITIONS
- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between **50 and 95 deg F (10 and 35 deg C)**.
 - B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. [Benjamin Moore & Co.](#)
 2. [Dunn-Edwards Corporation.](#)
 3. [Kelly-Moore Paint Company Inc.](#)
 4. [PPG Architectural Coatings.](#)
 5. [Sherwin-Williams Company \(The\).](#)

2.2 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. 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.
- C. **VOC Content:** For field applications, paints and coatings shall 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.
- D. Colors: Match Architect's samples.
1. Twenty five percent of surface area will be painted with deep tones.

2.3 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint 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 paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints 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. Concrete: 12 percent.
 - 2. Masonry (Clay and CMUs): 12 percent.
 - 3. Portland Cement Plaster: 12 percent.
 - 4. Gypsum Board: 12 percent.
- C. Portland Cement Plaster Substrates: Verify that plaster is fully cured.
- D. Exterior Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- E. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- F. 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 and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, 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.
- 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. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 - 1. SSPC-SP 3.

- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 - 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
 - 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 undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. 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.
- 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. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed to view:
 - a. Equipment, including panelboards and switch gear.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.

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. Concrete Substrates, Nontraffic Surfaces:
 - 1. Latex System MPI EXT 3.1K:
 - a. Prime Coat: Latex, exterior, matching topcoat.
 - b. Intermediate Coat: Latex, exterior, matching topcoat.
 - c. Topcoat: Latex, exterior, low sheen (Gloss Level 3-4), MPI #15.
 - d. Topcoat: Latex, exterior semi-gloss (Gloss Level 5), MPI #11.
 - e. Topcoat: Latex, exterior gloss (Gloss Level 6), MPI #119.
- B. Galvanized-Metal Substrates:
 - 1. Alkyd System MPI EXT 5.3B:
 - a. Prime Coat: Primer, galvanized, cementitious, MPI #26.
 - b. Intermediate Coat: Exterior, alkyd enamel, matching topcoat.
 - c. Topcoat: Alkyd, exterior, semi-gloss (MPI Gloss Level 5), MPI #94.
 - d. Topcoat: Alkyd, exterior, gloss (MPI Gloss Level 6), MPI #9

END OF SECTION

SECTION 09 9123
INTERIOR PAINTING

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 surface preparation and the application of paint systems on interior substrates.
- B. Related Requirements:
 - 1. Section 05 1200 "Structural Steel Framing" and Section 05 1213 "Architecturally Exposed Structural Steel Framing" for shop priming structural steel.
 - 2. Section 05 5000 "Metal Fabrications" for shop priming metal fabrications.
 - 3. Section 05 5113 "Metal Stairs" for shop priming metal pan stairs.
 - 4. Section 09 9300 "Staining and Transparent Finishing" for surface preparation and the application of wood stains and transparent finishes on interior wood substrates.

1.3 DEFINITIONS

- A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 - 2. Indicate VOC content.
- B. Sustainable Design Submittals:

1. **Product Data:** For paints and coatings, indicating VOC content.

C. Samples for Initial Selection: For each type of topcoat product.

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 (200 mm)** square.
2. Step coats 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: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

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. Paint: 5 percent, but not less than **1 gal. (3.8 L)** of each material and color applied.

1.6 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least **100 sq. ft. (9 sq. m)**.
 - b. Other Items: Architect will designate items or areas required.
2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 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 (7 deg C)**.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between **50 and 95 deg F (10 and 35 deg C)**.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. [Benjamin Moore & Co.](#)
 2. [Dunn-Edwards Corporation.](#)
 3. [Kelly-Moore Paint Company Inc.](#)
 4. [Sherwin-Williams Company \(The\).](#)

2.2 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. 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.
- C. **VOC Content:** For field applications that are inside the weatherproofing system, paints and coatings shall 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: 150 g/L.
 3. Dry-Fog Coatings: 400 g/L.
 4. Primers, Sealers, and Undercoaters: 200 g/L.
 5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
 7. Pretreatment Wash Primers: 420 g/L.
 8. Shellacs, Clear: 730 g/L.
 9. Shellacs, Pigmented: 550 g/L.
- D. Low-Emitting Materials: Interior paints and coatings shall 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."
- E. Colors: As indicated in Finish Schedule, A9.30
1. Twenty five percent of surface area will be painted with deep tones.

2.3 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint 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 paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints 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. Concrete: 12 percent.
 - 2. Masonry (Clay and CMU): 12 percent.
 - 3. Wood: 15 percent.
 - 4. Gypsum Board: 12 percent.
 - 5. Plaster: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Plaster Substrates: Verify that plaster is fully cured.
- E. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- F. 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 and recommendations in "MPI Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, 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. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.

- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.
- G. 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.
- H. 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 and to recommendations in "MPI Manual."
 - 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.
- 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. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed in equipment rooms:
 - a. Equipment, including panelboards and switch gear.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.
 - h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - 2. 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. Other items as directed by Architect.
3. 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 INTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Nontraffic Surfaces:
1. Institutional Low-Odor/VOC Latex System MPI INT 3.1M:
 - a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, flat (MPI Gloss Level 1), MPI #143.
 - d. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 2), MPI #144.
 - e. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3), MPI #145.
- B. Concrete Substrates, Traffic Surfaces:
1. Water-Based Concrete Floor Sealer System MPI INT 3.2G:
 - a. First Coat: Sealer, water based, for concrete floors, matching topcoat.
 - b. Topcoat: Sealer, water based, for concrete floors, MPI #99.
- C. CMU Substrates:
1. Institutional Low-Odor/VOC Latex System MPI INT 4.2E:

- a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 2), MPI #144.
 - d. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3), MPI #145.
- D. Steel Substrates:
- 1. Institutional Low-Odor/VOC Latex System MPI INT 5.1S:
 - a. Prime Coat: Primer, rust inhibitive, water based MPI #107.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 2), MPI #144.
 - d. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3), MPI #145.
 - e. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 4), MPI #146.
- E. Gypsum Board and Plaster Substrates:
- 1. Institutional Low-Odor/VOC Latex System MPI INT 9.2M:
 - a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, flat (MPI Gloss Level 1), MPI #143.
 - d. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 2), MPI #144.
 - e. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3), MPI #145.
 - f. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 4), MPI #146.

END OF SECTION

SECTION 10 1100
VISUAL DISPLAY UNITS

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. Field assembled, frameless tackable wall surface.
- B. Related Requirements;
 - 1. Section 06 1053 "Miscellaneous Rough Carpentry"
 - 2. Section 08 8000 "Glazing" for interior glazing not installed as part of visual display system
 - 3. Section 09 2900 "Gypsum Board"

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.
- B. Shop Drawings: For visual display units.
 - 1. Include plans, elevations, sections, details, and attachment to other work.
 - 2. Show location of panel joints
 - 3. Include sections of typical trim members.
- C. Samples: 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.
- D. Product Schedule: For visual display units. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of tackboards.

- C. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For visual display units to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for installation required.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockup of typical Message Board (MB-1) in location directed by Architect. Include accessories.
 - 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.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 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.

1.9 PROJECT 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.
- B. Field Measurements: Verify actual dimensions of construction contiguous with visual display units by field measurements before fabrication.
 - 1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

1.10 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: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of visual display unit from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; 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.

2.3 TACKABLE WALL SURFACE

- A. Tackboard Material:
 - 1. 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.
- B. Basis of Design: Subject to compliance with requirements, provide product indicated on Sheet A9.30 Finish Schedule, or comparable products by one of the following
 - 1. [Walltalkers](#)
- C. Color: As indicated on Finish Schedule, A9.30.
- D. Size: As indicated on Drawings.
- E. End Stops: Aluminum.

2.4 MATERIALS

- A. Tackboard Panel: Self-healing resilient tackboard panel on core indicated for installation in wall recess
- B. Clear Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering.
- C. Porcelain-Enamel Face Sheet: ASTM A 424, enameling-grade steel, uncoated thickness indicated; with exposed face and edges coated with primer, 1.7-to-2.5-mil-thick ground coat, and color cover coat; and with concealed face coated with primer and 1.7-to-2.5-mil- thick ground coat.
 - 1. Gloss-Finish Cover Coat: Gloss as indicated; dry-erase markers wipe clean with dry cloth or standard eraser. Minimum 3.0-to-4.0-mil- thick cover coat. Cover and ground coats shall be fused to steel at manufacturer's standard firing temperatures but not less than 1475 deg F.
- D. Extruded Aluminum: **ASTM B 221 (ASTM B 221M)**, Alloy 6063.
- E. Composite Wood: No added urea formaldehyde

- F. 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.
- G. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Section 09 9123 "Interior Painting" and recommended in writing by visual display unit manufacturer for intended substrate.

2.5 GENERAL FINISH REQUIREMENTS

- 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 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.

2.6 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 walls and partitions for proper preparation and backing for visual display units.
- C. 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.
- E. Prepare recesses for visual display units as required by type and size of unit.

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. Provide manufacturer's standard vertical-joint spline system between abutting sections of markerboards. Clearly mark spline system joints for properly installed configuration in the field.
 - 2. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as indicated on approved Shop Drawings.
 - 3. 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.

3.4 CLEANING AND PROTECTION

- A. Clean visual display units according to 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

SECTION 10 1423

PANEL SIGNAGE

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. Comply with Goucher College Graphic Standards and Design Standards for Signage Fabrication and Layout.

1.2 SUMMARY

- A. Section Includes:
 - 1. This section specifies interior plastic photopolymer signage on metal base for room numbers, directional signs, code required signs, telephone identification signs and temporary interior signs.

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.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For panel 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 others, and accessories.
 - 3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
 - 1. Include representative Samples of available typestyles and graphic symbols.
 - 2. Cast-Acrylic sheet.
 - 3. Tackable Surface
 - 4. Stainless Steel Edge
- 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. Cast-Acrylic Sheet: 8 by 10 inches (200 by 250 mm) for each color required.
 - 2. Panel Signs: Full-size Sample including edge.

3. Variable Component Materials: Full-size Sample of each base material, character (letter, number, and graphic element) in each exposed color and finish not included in Samples above.
4. Exposed Accessories: Full-size Sample of each accessory type.

- E. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and fabricator. Sign manufacturer shall provide evidence that they regularly and presently manufacturer signs similar to those specified in this section as one of their principal products.
- B. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. 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.
- C. Source Limitations for Signs: Obtain each sign type indicated from one source from a single manufacturer.
- D. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.9 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit installation of signs in exterior locations to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify recess openings and glass side lite dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 DELIVERY AND STORAGE

- A. Deliver materials to job in manufacturer's original sealed containers with brand name marked thereon. Protect materials from damage.
- B. Package to prevent damage or deterioration during shipment, handling, storage and installation. Maintain protective covering in place and in good repair until removal is necessary.
- C. Deliver signs only when the site and mounting services are ready for installation work to proceed.

- D. Store products in dry condition inside enclosed facilities.

1.11 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. Thermal Movements: For exterior signs, 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.
- B. Accessibility Standard: 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 for signs.

2.2 SIGNS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or University Approved Signage Manufacturer:
 - 1. [Allen Markings International](#).
 - 2. [ASI Sign Systems, Inc.](#)
 - 3. [Best Sign Systems Inc.](#)
 - 4. [Mohawk Sign Systems.](#)
 - 5. [Nelson-Harkins Industries.](#)
- B. Interior Panel Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
 - 1. Acrylic Sheet: 0.060 inch (1.52 mm) thick.
 - 2. Sign-Panel Perimeter: Finish edges smooth.
 - a. Edge Condition: Square cut.
 - b. Corner Condition in Elevation: Square.
 - 3. Mounting: As indicated.
 - a. Wall mounted with concealed anchors or two-face tape.
 - b. Manufacturer's standard anchors for substrates encountered.
 - 4. Color of Panel: Match Pantone Cool Gray 8 C
 - 5. Color of Graphics/Characters/Lettering: White
 - 6. Tactile Characters: Characters and Grade 2 Braille raised 1/32 inch (0.8 mm) above surface
 - 7. Flatness Tolerance: Sign panel shall remain flat or uniformly curved under installed conditions as indicated and within a tolerance of plus or minus 1/16 inch (1.5 mm) measured diagonally from corner to corner.
- C. Brackets: Fabricate brackets and fittings for bracket-mounted signs from extruded aluminum to suit panel sign construction and mounting conditions indicated. Factory paint brackets in color matching Architect's sample.

- D. Tactile and Braille Sign: Manufacturer's standard process for producing text and symbols complying with ADA-ABA Accessibility Guidelines and with ICC/ANSI A117.1. Text shall be accompanied by Grade 2 Braille. Produce precisely formed characters with square-cut edges free from burrs and cut marks; Braille dots with domed or rounded shape.
 - 1. Panel Material: Opaque acrylic sheet.
 - 2. Raised-Copy Thickness: Not less than 1/32 inch (0.8 mm).
- E. Acrylic-modified P.E.T.G. with photopolymer laminate, computer-generated copy and graphics are photo-exposed to photopolymer and factory processed to create raised copy and grade 2 braille message, integral with sign background. Pictograms and other artwork to be processed photopolymer raised image.
- F. Changeable Paper/ Insert Holder for Faculty Office Signage - Extruded insert holder with integral Rail Insert for connection with structural back panel in 6063T5 aluminum with color as selected by the Architect. Inserts into holder are paper with a clear 0.7 mm (.030 inches) textured cover. Background color is painted in acrylic lacquer.

2.3 PANEL-SIGN MATERIALS

- A. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).
- B. Modified Acrylic (P.E.T.G.), matte clear with photopolymer laminate sheets: Provide light-sensitive, water-wash photopolymer face layer bonded to P.E.T.G. base layer to produce a composite sheet with overall thickness of (1/8 inch, 1/16 or 1/4 inch).
- C. Raised copy, graphic symbols and braille to be integral with sign background. Glued-on or milled braille is unacceptable.
- D. Unframed Panel Signs: Fabricate signs with edges mechanically and smoothly finished to comply with the following requirements:
 - 1. Edge condition: Square cut
- E. Stainless Steel Edge for framed signs:
 - 1. Color: To match color of Valance
 - 2. Width: 1/4" wide
 - 3. Finish: #4, brushed directional or satin finish
 - 4. Edge condition: Square cut
- F. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, 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.
 - b. Fastener Heads: For nonstructural connections, use oval countersunk screws and bolts with tamper-resistant Allen-head slots unless otherwise indicated.
 - 4. Sign Mounting Fasteners:

- a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.
5. Inserts: Furnish inserts to be set by other trades into concrete or masonry work.

- B. Adhesives: As recommended by sign manufacturer and with a VOC content of 70 g/L or less for adhesives used inside the weatherproofing system and applied on-site when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch (1.14 mm) thick, with adhesive on both sides.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

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. 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 signs for stability and for securing fasteners.
 6. Provide rebates, lugs, and brackets 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. Signs with Changeable Message Capability: Fabricate signs to allow insertion of changeable messages as follows:
 1. For slide-in changeable inserts, fabricate slot without burrs or constrictions that inhibit function. Furnish initial changeable insert. Furnish two blank inserts for each sign for Owner's use.
 2. For frame to hold changeable sign panel, fabricate frame without burrs or constrictions that inhibit function. Furnish initial sign panel..

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.
- 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.

2.7 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - 2. Directional Satin Finish: No. 4.

2.8 ACRYLIC SHEET FINISHES

- A. Colored Coatings for Acrylic P.E.T.G. Sheet: For copy and background colors, provide Pantone Matching System (PMS) colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and that are UV and water resistant for five years for application intended.
- B. For photopolymer raised-copy, provide manufacturer's standard hot-stamp foil colors in full range available.

2.9 SIGN STANDARDS

- A. Topography: Provide sign copy that complies with requirements indicated below and in the sign schedule and drawings for size, style, spacing, content, mounting height and location, material, finishes and colors of signage
 - 1. Type Style: Rotis Raised Color TBD.
 - 2. Arrow: See graphic standards in drawings.
 - 3. Letter spacing: See graphic standards on drawings.
 - 4. All text, arrows, and symbols to be provided in size, colors, typefaces and letter spacing shown. Text shall be a true, clean, accurate reproduction of typeface(s) shown. Text shown in drawings are for layout purposes only; final text for signs is listed in Sign

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 of signage work.
- 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. Verify that anchor inserts are correctly sized and located to accommodate signs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.
 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. Room-Identification Signs and Other Accessible Signage: Install in locations on walls as indicated and according to accessibility standard.
1. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable.
 2. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches (75 mm) of sign without encountering protruding objects or standing within swing of door.
- C. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply
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.
 2. 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. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.
 4. Where signs are scheduled or indicated to be mounted on glass, provide matching acrylic back plate at reverse-side of glass to conceal mounting materials.
- D. Bracket-Mounted Signs: Provide manufacturer's standard brackets, fittings, and hardware for mounting signs that project at right angles from walls and ceilings. Attach brackets and fittings securely to walls and ceilings with concealed fasteners and anchoring devices to comply with manufacturer's written instructions.

3.3 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

SECTION 10 2800

TOILET AND BATH ACCESSORIES

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. Public-use washroom accessories.
2. Shower enclosure accessories
3. Warm Air Dryers
4. Custodial accessories.

B. Related Sections:

1. Section 05 5000 "Metal Fabrications" for steel supports above ceiling in toilet rooms to support ceiling hung partitions, steel tube countertop supports
2. Section 06 1053 "Miscellaneous Rough Carpentry" for blocking in walls to support mounting of toilet accessories
3. Section 10 2116 "Phenolic-Core Toilet and Changing Room Compartments" for public restroom ceiling hung phenolic core toilet partitions
4. Section 12 3661 "Countertops" for countertops with integral sink bowls at restroom vanity

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include the following:

1. Construction details and dimensions.
2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Material and finish descriptions.
4. Features that will be included for Project.
5. Manufacturer's warranty.
6. Include electrical characteristics

B. Samples: Full size, for each accessory item to verify design, operation, and finish requirements.

1. Approved full-size samples will be returned and may be used in the Work.

C. Shop Drawings: For shower and dressing compartments.

1. Include plans, elevations, sections, and attachment details.
2. Show locations of cutouts for compartment-mounted accessories.
3. Show locations of centerlines of drains.
4. Include field measured dimensions to verify clearances for shower enclosure

D. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify products using designations indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.

1.7 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.

1.8 WARRANTY

- A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED MATERIALS

- A. Owner-Furnished Materials:
 - 1. Childcare Changing Station

2.2 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.

2.3 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch (0.8-mm) minimum nominal thickness unless otherwise indicated.
- B. Brass: ASTM B 19, flat products; ASTM B 16/B 16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.
- C. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch (0.9-mm) minimum nominal thickness.
- D. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 (Z180) hot-dip zinc coating.

- E. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- F. 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.
- G. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- H. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.
- I. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

2.4 WASHROOM AND SHOWER ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
 - 1. Bobrick Washroom Equipment, Inc.
 - 2. Bradley Corporation.
- A. Toilet Tissue (Roll) Dispenser:
 - 1. Basis of Design: Tork Twin Jumbo Bath Tissue Roll Dispenser 56TR for 9-inch roll
 - 2. Color: Smoke
 - 3. Mounting: Surface mounted.
- B. Liquid-Soap Dispenser:
 - 1. Basis of Design: GOJO Provon NXT Space Saver Dispenser 2115-06; Push-Style Dispenser for GOJO Lotion Soap, Shower Soap or Lotion.
 - 2. Color: Dove Grey
 - 3. Mounting: Surface mounted
- C. Sanitary-Napkin Disposal Unit:
 - 1. Basis of Design: Bobrick Model B-270
 - 2. Mounting: Surface and Partition mounted.
 - 3. Door or Cover: Self-closing, top hinged disposal-opening cover for access and servicing
 - 4. Material and Finish: Stainless steel, No. 4 finish (satin).
- D. Waste Receptacle:
 - 1. Basis of Design: Bobrick Model B-3644
 - 2. Mounting: Recess mounted.
 - 3. Minimum Capacity: 12 gal
 - 4. Material and Finish: Stainless steel, No. 4 finish (satin).
 - 5. Interior Liner Hooks: Reusable vinyl liner OFOI.
 - 6. Lockset: Tumbler type for waste receptacle.
- E. Towel Pin
 - 1. Basis of Design: ASI 7301
 - 2. Description: 1/2 inch x 1-inch rectangular tubing with formed mounting flange and bracket welded on end.
 - 3. Mounting: Flanges with concealed fasteners.
 - 4. Length extended from wall: **3-1/2 inches**
 - 5. Material and Finish: Heavy Gage stainless steel
 - 6. Mounting: Concealed wall plate, no exposed fasteners
- F. Towel Bar
 - 1. Basis of Design: ASI 7355

2. Description: **3/4-inch- (19-mm-)** diameter tube with square end brackets.
3. Mounting: Flanges with concealed fasteners.
4. Length: **24 inches (610 mm)**.
5. Material and Finish: Heavy Gage stainless steel
6. Mounting: Concealed wall plate, no exposed fasteners
7. Location: Unit and Staff Apartment Bathrooms – Two per bathroom

- G. Shower Curtain for ADA Transfer Showers, mildew resistant: Weighted bottom with 4 inch lip and Velcro sides form a temporary water barrier, system complying with ADA Standards
1. Basis of Design: InPro ADA Shower Curtains, Super Bio Stat material hung via Clickeze Privacy System components

- H. Mirror Unit
1. Basis-of-Design Product: American Specialties, Inc (ASI) Model No. 0620
 2. Frame: Stainless-steel.
 - a. Corners: Manufacturer's standard channel frame
 3. Surface Mounted, at height indicated on Drawings
 4. Size: As indicated on Drawings.

2.5 WARM-AIR DRYERS

- A. Source Limitations: Obtain warm-air dryers from single source from single manufacturer.
- B. High-Speed Warm-Air Dryer:
1. Basis of Design: TOTO HDR111#SS
 2. Description: High-speed, warm-air hand dryer for rapid hand drying.
 3. Mounting: Recessed, concealed – ADA compliant
 4. Operation: Electronic-sensor activated with operation time of 10 to 20 seconds. Reusable washable filter
 5. Cover Material and Finish: Stainless steel, No. 4 finish (satin).
 6. Electrical Requirements: 120V AC – 4.25Amps – 510W – 60Hz.

2.6 CHILDCARE ACCESSORIES (OFCI)

- A. Source Limitations: Obtain childcare accessories from single source from single manufacturer.
- B. Diaper-Changing Station:
1. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
 - a. Engineered to support minimum of **250-lb (113-kg)** static load when opened.
 2. Mounting: Surface mounted, with unit projecting not more than **4 inches (100 mm)** from wall when closed.
 3. Operation: By pneumatic shock-absorbing mechanism.
 4. Material and Finish: Stainless steel, No.4 finish (satin), exterior shell with rounded plastic corners; HDPE interior in manufacturer's standard color.
 5. Liner Dispenser: Built in.

2.7 CUSTODIAL ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
1. Bobrick Washroom Equipment, Inc.
 2. Bradley Corporation.

- B. Mop and Broom Holder with Shelf:
 - 1. Basis of Design: ASI 1308
 - 2. Description: Unit with holders.
 - 3. Length: 34 inches
 - 4. Hooks: Four.
 - 5. Mop/Broom Holders: Three
 - 6. Material and Finish: Stainless steel, No. 4 finish (satin).
 - a. Shelf: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel.

2.8 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 (1112 N), 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 recommendations.

END OF SECTION

PART 4 -

SECTION 10 4413

FIRE PROTECTION CABINETS

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. Fire-protection cabinets for the following:
 - a. Portable fire extinguishers.
- B. Related Requirements:
 - 1. Section 10 4416 "Fire Extinguishers."

1.3 PREINSTALLATION CONFERENCE

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to fire-protection cabinets including, but not limited to, the following:
 - a. Schedules and coordination requirements.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. 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. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Initial Selection: For each type of exposed finish required.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples 6 by 6 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.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.6 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 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

2.2 FIRE-PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
 - 1. Basis of Design Product: Subject to compliance with requirements, provide Larsen's model #0-2409 or comparable product by one of the following:
 - a. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - b. Potter Roemer LLC.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Babcock-Davis.
 - b. Guardian Fire Equipment, Inc.
 - c. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - d. Larsens Manufacturing Company.
 - e. Nystrom, Inc.
 - f. Potter Roemer LLC.
- B. Cabinet Construction: UL listed with fire resistance rating of hall where it is installed.
 - 1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch- (1.09-mm-) thick cold-rolled steel sheet lined with minimum 5/8-inch- (16-mm-) thick fire-barrier material. Provide factory-drilled mounting holes.
 - 2. Shelf: Same metal and finish as cabinet.
- C. Fully recessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
 - 1. Square-Edge Trim: 1-1/4- to 1-1/2-inch (32- to 38-mm) backbend depth.
- D. Cabinet Trim Material: Steel sheet.
- E. Door Material: Steel sheet.
 - 1. Basis of Design: Larsen's type suffix RK, RL, or RM.
- F. Door Style
 - 1. Basis of Design: Larsen Door style with lock and "breakaway acrylic panel".
- G. Door Glazing: Acrylic sheet.
 - 1. Acrylic Sheet Color: Clear transparent acrylic sheet.
- H. 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 lever handle with cam-action latch.
2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

I. 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. Door Lock: Cylinder lock, keyed alike to other cabinets.
4. 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 door.
 - 2) Application Process: Pressure-sensitive vinyl letters.
 - 3) Lettering Color: Red.
 - 4) Orientation: Vertical.
5. Alarm: Manufacturer's standard alarm that actuates when fire-protection cabinet door is opened and that is powered by batteries.

J. Materials:

1. Cold-Rolled Steel: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
 - a. Finish: Baked enamel or powder coat.
 - b. Color: As selected by Architect from full range of industry colors and color densities.
2. Transparent Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), 3 mm thick, with Finish 1 (smooth or polished).

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. Provide factory-drilled mounting holes.
 3. Prepare doors and frames to receive locks.
 4. Install door locks at factory.
- 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. Miter and weld perimeter door frames.
- 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 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 roughing-in for cabinets to verify actual locations of piping connections before cabinet installation.
- B. Examine walls and partitions for suitable framing depth and blocking where semirecessed cabinets will be installed.
- C. 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.
- 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. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
 - 3. Fire-Rated Cabinets:
 - a. Install cabinet with not more than **1/16-inch (1.6-mm)** tolerance between pipe OD and knockout OD. Center pipe within knockout.
 - b. Seal through penetrations with firestopping sealant as specified in Section 07 8413 "Penetration Firestopping."
- C. Identification: Apply vinyl lettering at locations indicated.

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

SECTION 10 4416
FIRE EXTINGUISHERS

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 portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.
- B. Owner-Furnished Material: Hand-carried fire extinguishers.
- C. Related Requirements:
 - 1. Section 10 4413 "Fire Protection Cabinets."

1.3 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.6 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.7 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.
 - 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, provide products by one of the following:
 - a. [Amerex Corporation](#).
 - b. [JL Industries, Inc.; a division of the Activar Construction Products Group](#).
 - c. [Kidde Residential and Commercial Division](#); Subsidiary of Kidde plc.
 - d. [Larsens Manufacturing Company](#).
 - e. [Potter Roemer LLC](#).
 - 2. Valves: Manufacturer's standard.
 - 3. Handles and Levers: Manufacturer's standard.
 - 4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
- 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 black baked-enamel finish.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [Amerex Corporation](#).
 - b. [JL Industries, Inc.; a division of the Activar Construction Products Group](#).
 - c. [Larsens Manufacturing Company](#).
 - d. [Potter Roemer LLC](#).
- 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: Horizontal.

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.
 - 1. Mounting Brackets: 54 inches (1372 mm) above finished floor to top of fire extinguisher.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION

SECTION 11 3100
RESIDENTIAL APPLIANCES

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. Cooking appliances.
 - 2. Kitchen exhaust ventilation.
 - 3. Refrigeration appliances.
 - 4. Cleaning appliances.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include installation details, material descriptions, dimensions of individual components, and finishes for each appliance.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
- B. Sustainable Design Submittals:
 - 1. Product Data: For indicated products, indicating compliance with requirements for ENERGY STAR product labeling.
- C. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard size.
- D. Product Schedule: For appliances. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Product Certificates: For each type of appliance.
- C. Field quality-control reports.
- D. Sample Warranties: For manufacturers' special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each residential appliance to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintains, within 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- B. Installer Qualifications: An employer of workers trained and approved by manufacturer for installation and maintenance of units required for this Project.

1.8 WARRANTY

- A. Special Warranties: Manufacturer agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period.
- A. Electric Range: Limited warranty, including parts and labor for first year and parts thereafter, for on-site service on surface-burner elements.
- B. Microwave Oven: Limited warranty, including parts and labor for first year and parts thereafter, for on-site service.
- C. Dishwasher: Limited warranty, including parts and labor for first year and parts thereafter, for on-site service on the product.
- D. Refrigerator/Freezer, Sealed System: Limited warranty, including parts and labor for first year and parts thereafter, for on-site service on the product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers Subject to compliance with requirements, provide Basis of Design Models listed below, or approved equal by one of the listed manufacturers:
 - 1. GE Electric Company – Basis of Design models for typical residential installations
 - 2. Dacor – Basis of Design for Commercial Grade appliances selected for Ground Level Kitchen
 - 3. Amana; a division of Whirlpool Corporation.
 - 4. KitchenAid; a division of Whirlpool Corporation.
 - 5. Maytag; a division of Whirlpool Corporation.
 - 6. Whirlpool Corporation.
- B. Source Limitations: Obtain residential appliances from single source and each type of residential appliance from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Appliances: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with applicable provisions in ICC A117.1.

2.3 RANGETOPS

- A. Electric Cooktop
 1. Basis of Design: GE 36" Built-In Touch-Control Electric Cooktop JP5036SJSS
 2. Burner Configuration: 5 Ribbon Smoothtop
 3. Control Location: Front Center
 4. Control Type: Electronic Touch

2.4 WALL OVENS

- A. Double Wall Oven
 1. Basis of Design: GE 24" Double Wall Oven JRP28SKSS
 2. Capacity 2.7 cu.ft (Upper) / 2.7 cu. Ft (Lower)
 3. Electronic touch controls location comply with ADA requirements.
 4. Coordinate construction of surrounding cabinetry to meet temperature exposure performance requirements outlined by Manufacturer of wall oven.

2.5 MICROWAVE OVENS

- A. **Basis of Design:** Subject to compliance with requirements, provide Basis of Design Products listed below, or submit substitution for approval as per Division 01 Substitution Procedures
 1. Basis-of-Design Product: GE Profile Series Countertop Microwave Oven PEB7226SFSS
 2. Type: Conventional.
 3. Dimensions:
 - a. Width: 24 1/8"
 - b. Depth: 19 3/4"
 - c. Height: 14"
 4. Capacity: 2.2 cu. Ft.
 5. Oven Door: Door with observation window.
 6. Microwave Power Rating: Manufacturer's standard.
 7. Electric Power Supply: 700W
 8. Controls: Digital panel controls and timer display.
 9. Other Features: Turntable, cooktop lighting, control lockout
 10. Finish: Stainless Steel
 11. Provide Accessory Trim Kit for Built-In Look, GE JX7227SFSS

2.6 KITCHEN EXHAUST VENTILATION

- A. Wall Mount Exhaust Hood:
 1. Basis-of-Design Product: GE 36" Wall Mount Pyramid Chimney Hood, JVW5361SJSS
 2. Type: Wall Mounted
 3. Dimensions:
 - a. Width: 36"
 - b. Depth: 18 1/2"
 - c. Height: 9 3/4"
 4. Exhaust Fan: Four-speed speed fan built into hood and with manufacturer's standard capacity.
 - a. Venting: Non-vented, recirculating type with charcoal filter
 - b. Fan Control:

- 1) Provide conversion kit for ADA accessible, wall-mounted fan switch, with separate hood-light control switch. Both switches to be mounted as required for ADA accessibility.
 - a) GE Optional Power Cord Kit: JXHC1.
5. Finish: stainless steel
6. Features:
 - a. Removable, charcoal filter(s).
 - b. Built-in cooktop lighting with on/off controls

2.7 REFRIGERATOR/FREEZER

- A. Refrigerator/Freezer: Two-door refrigerator with bottom freezer Drawer, complying with AHAM HRF-1.
 1. Basis-of-Design Product: GE Model #GFE26GSHSS
 2. Type: Freestanding.
 3. Storage Capacity: 25.7 cu. Ft.
 4. General Features:
 - a. Door Configuration: French Door
 - b. Hidden hinges
 5. Refrigerator Features:
 - a. Interior light in refrigeration compartment.
 - b. Compartment Storage: Adjustable humidity vegetable/fruit crisper.
 - c. Temperature-controlled meat/deli bin.
 6. Freezer Features: Full width freezer rack
 - a. Automatic defrost.
 - b. Interior light in freezer compartment.
 - c. Freezer door bin and full width wire basket
 7. Energy Performance, ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

2.8 DISHWASHER

- A. Dishwasher: Built-in dishwasher with stainless steel interior, hidden controls, complying with AHAM DW-1, ADA compliant.
 1. Basis of Design: GE Model GLDT696DSS
 2. Finish: Stainless Steel
 3. Type: Built-in undercounter.
 4. Dimensions:
 - a. Width: 24 inches
 - b. Depth: 24 inches
 - c. Height: 32-7/20 inches adjustable to 34-1/2 inches
 5. Capacity: Manufacturer's Standard
 6. Sound Level: Maximum 55 dBA.
 7. Tub and Door Liner: Manufacturer's standard
 8. Rack System: Manufacturer's standard
 9. Controls: Touch-pad controls with minimum four wash cycles and hot-air and heat-off drying cycle options.
 10. Energy Performance, ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product-labeling program.
 11. Front Panel: White
 12. Appliance Color/Finish: Stainless Steel

2.9 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 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of residential appliances.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before appliance installation.
- C. Examine walls, ceilings, and roofs for suitable conditions where overhead exhaust hoods and microwave ovens with vented exhaust fans will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install appliances according to manufacturer's written instructions.
- B. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and that rough openings are completely concealed.
- C. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.
- D. Range Anti-Tip Device: Install at each range according to manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
 - 2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After installation, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.

- B. An appliance will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain residential appliances.

END OF SECTION

SECTION 12 2413

ROLLER WINDOW SHADES

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. Manually operated roller shades with single rollers.
- B. Related Requirements:
 - 1. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include styles, material descriptions, construction details, 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.
- C. Samples: For each exposed product and for each color and texture specified, 10 inches (250 mm) long.
- D. Roller-Shade Schedule: Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of shadeband material, signed by product manufacturer.
- C. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roller shades to include in 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. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than two units.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 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.

1.9 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.

1.10 WARRANTY

- A. Manufacturer's Warranty: 25 Years from Date of Substantial Completion
- B. Installer's Warranty: 1 Year from Date of Substantial Completion

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide MechoShade Systems, Inc or comparable product by one of the following:
 1. Draper Inc.
 2. Hunter Douglas Contract.
 3. Lutron Electronics Co., Inc
- B. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. 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: Manufacturer's standard.
 - 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 (4.5 kg) or for shades as recommended by manufacturer, whichever criterion is more stringent.
- B. 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 inside face of shade.
 - 2. Direction of Shadeband Roll: Regular, from back of roller.
 - 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- D. 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.
- E. Shadebands:
 - 1. Shadeband Material: Light-filtering fabric, Complying with NFPA 701.
 - 2. Light-Filtering Fabric: 100% Thermoplastic Olefin (TPO).
 - 3. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.
- F. Installation Accessories:
 - 1. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband when shade is fully open, but not less than **4 inches (102 mm)**.
 - 2. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 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.
- A. Light-Filtering Fabric: PVC-Free, Woven fabric, stain and fade resistant.
 - 1. Basis of Design: MechoShade Ecoveil 1350 Series
 - 2. Type: Thermoplastic Olefin
 - 3. Weave: Basketweave.
 - 4. Fabric Thickness: 0.030 inch
 - 5. Roll Width: Maximum required to cover glazing indicated
 - 6. Orientation on Shadeband: Up the bolt.
 - 7. Openness Factor: 3 percent.

8. Color: As selected by Architect from manufacturer's full range.

2.4 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: Fabricate units in sizes to fill window and other openings as follows, measured at **74 deg F (23 deg C)**:
 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less **1/4 inch (6 mm)** per side or **1/2-inch (13-mm)** total, plus or minus **1/8 inch (3.1 mm)**. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less **1/4 inch (6 mm)**, plus or minus **1/8 inch (3.1 mm)**.
- 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.
 2. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate 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 (51 mm)** to interior face of glass. Allow clearances for window operation hardware.
- B. Electrical Connections: Connect motor-operated roller shades to building electrical system.
- C. Roller Shade Locations: At 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.

END OF SECTION

SECTION 12 3660

COUNTERTOPS

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. Solid-surface-material countertops and backsplashes.
 - 2. Quartz agglomerate countertops and backsplashes.
- B. Related Requirements:
 - 1. Section 22 4100 "Residential Plumbing Fixtures" for non-integral sinks and plumbing fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For countertop materials and sinks.
- B. Shop Drawings: For countertops. 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.
- C. Samples for Initial Selection: For each type of material exposed to view.
- D. Samples for Verification: For the following products:
 - 1. Countertop material, 6 inches (150 mm) square.
 - 2. One full-size solid-surface-material countertop, with front edge and backsplash, 8 by 10 inches (200 by 250 mm), of construction and in configuration specified.
 - 3. One full-size quartz agglomerate countertop, with front edge and backsplash, 8 by 10 inches (200 by 250 mm), of construction and in configuration specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Product Certificates: For the following:
 - 1. Composite wood and agrifiber products.
 - 2. Adhesives.

1.5 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.

1.6 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.
- C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
 - 1. Build mockup of typical countertop as shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- D. Environmental Limitations: Do not deliver or install countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between **60 and 90 deg F (16 and 32 deg C)** and relative humidity between 25 and 55 percent during the remainder of the construction period.
- E. Field Measurements: Where 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.
- F. Established Dimensions: Where countertops are indicated to fit to other construction, establish dimensions for areas where countertops are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.7 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 surfaces of countertops covered with protective covering during handling and installation.
- D. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

- A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.
 - 1. Basis of Design (Countertop): Subject to compliance with requirements, provide products listed on Finish Schedule, or comparable products and price groups by one of the following:
 - a. [Corian by E.I. du Pont de Nemours and Company](#)
 - b. [Hi-Macs \(BASIS OF DESIGN\)](#)
 - c. [Avonite Surfaces](#)
 - 2. Integral Sink Bowls: Comply with CSA B45.5/IAPMO Z124.

3. Colors and Patterns: As indicated in Finish Schedule, A9.30.

2.2 QUARTZ AGGLOMERATE COUNTERTOP MATERIALS

- A. Quartz Agglomerate: Solid sheets consisting of quartz aggregates bound together with a matrix of filled plastic resin and complying with ICPA SS-1, except for composition.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cambria.
 - b. Cosentino USA.
 - c. E. I. du Pont de Nemours and Company.
 - d. LG Chemical, Ltd.
 - e. Meganite Inc.
 - f. Samsung Chemical USA, Inc.
 - g. Technistone USA, Inc.
 - h. Transolid Div of Trumbull Industries.
 - i. Wilsonart.
 2. Colors and Patterns: As indicated in Finish Schedule, A9.30

2.3 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard unless otherwise indicated.
 1. Wood Moisture Content: 5 to 10 percent.
- B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of interior architectural woodwork and quality grade specified unless otherwise indicated.
 1. Composite Wood Products: Products shall be made without urea formaldehyde.
 2. Medium-Density Fiberboard: ANSI A208.2, Grade 130, made with binder containing no urea formaldehyde.
 3. Medium Density Fiberboard (MDF): ANSI 208.2
 - a. Basis of Design: "Medite II," 3/4 inch thick, by SierraPine Composite Solutions, Roseville, CA.
 4. Particleboard: Straw-based particleboard complying with requirements in ANSI A208.1, Grade M-2, except for density.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Environ Biocomposites Manufacturing LLC.
 - 2) Sorm Incorporated.
 5. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded
 6. Hardwood Veneer Plywood: HPVA HP-1, Non-toxic, urea formaldehyde free: with soy-based adhesive:
 - a. Basis of Design: Purebond by Columbia Forest Products Inc.
 7. Fire Rated Plywood FR plywood at secure walls: Either DOC PS 1 or DOC PS 2, Exposure 1 sheathing.
 8. Nominal Thickness: Not less than 1 1/8 inches and as indicated.

2.4 COUNTERTOP 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.
 - 2. Backsplash: Straight, slightly eased at corner.
 - 3. End Splash: Matching backsplash.
- C. Countertops: **3/4-inch- (19-mm-)** thick, material with front edge built up with same material.
- D. Backsplashes: **3/4-inch- (19-mm-)** thick, material.
- E. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with 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.
- F. Joints: Fabricate countertops in sections for joining in field, with joints at locations indicated.
 - 1. Joint Locations: Not within **18 inches (450 mm)** of a sink or cooktop and not where a countertop section less than **36 inches (900 mm)** long would result, unless unavoidable.
 - 2. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints where indicated. Make width of cuts slightly more than thickness of splines to provide snug fit. Provide at least three splines in each joint.
- 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 (5 mm)** 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.

2.5 INSTALLATION MATERIALS

- A. **Adhesives:** Do not use adhesives that contain urea formaldehyde.
- B. Adhesive: Product recommended by countertop manufacturer.
 - 1. **Adhesives shall have a VOC** content of 70 g/L or less.
- C. Sealant for Countertops: Comply with applicable requirements in Section 07 9200 "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 (3 mm in 2.4 m)**, **1/4 inch (6 mm)** maximum. Do not exceed **1/64-inch (0.4-mm)** difference between planes of adjacent units.
- B. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- C. 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.
- D. 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 where indicated. 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.
- E. 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.
- 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. Pre-drill 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 07 9200 "Joint Sealants."

END OF SECTION

SECTION 12 4813

CARPET ENTRANCE SYSTEM

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. Carpet tile entrance systems

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For the following products, in manufacturer's standard sizes:
 - 1. Floor Mat: 12 inch by 12 inch.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For floor mats and frames 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. Entrance Mats: Full-size tile units equal to 2 percent of amount installed, but no fewer than 10 units.

PART 2 - PRODUCTS

2.1 ENTRANCE FLOOR MATS, GENERAL

- A. 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.
- B. CRI Green Label Plus Certification

2.2 CARPET TILE ENTRANCE SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Tandus Abrasive Action II, or approved equal.
 - 1. Construction: Bulked Continuous Filament Nylon Fiber Patterned Loop Pile
 - a. For yarn containing recycled content, report post-consumer and post-industrial recycled content of the pile face yarn based on total yarn weight.
 - b. Fiber to contain carbon-core filament for permanent static control

2. Colors, Textures, and Patterns: As shown on Finish Schedule, Sheet A9.30
3. Tile Size: As shown on Finish Schedule, Sheet A9.30
4. Face Weight: 24 oz./sq.yd.
5. Pile Height: 0.187 inch
6. Backing: Non-woven synthetic fiber

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and floor conditions for compliance with requirements for location, sizes and other conditions affecting installation of floor mats and frames.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Floor Mats
 1. Install with manufacturer approved adhesive.
 2. Install surface-type units to comply with manufacturer's written instructions at locations indicated; coordinate with entrance locations and traffic patterns.

3.3 PROTECTION

- A. After completing frame installation and concrete work, provide temporary filler of plywood or fiberboard in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

END OF SECTION

SECTION 12 9300

SITE FURNISHINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following site and street furnishings:
1. Bicycle Rack
- B. Related Sections include the following:
1. Division 2 Section *Earthwork* for excavation for installation of concrete footings.
 2. Division 3 Section *Cast-in-Place Concrete* for installation of anchor bolts cast in concrete footings.
- C. Products furnished, but not installed under this Section, include anchor bolts to be cast in concrete footings.

1.3 SUBMITTALS

- A. Comply with Division 1 Section *Submittal Procedures*.
- B. For Approval:
1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, field-assembly requirements, and installation details.
 2. Samples for Verification: For each type of exposed finish required.
- A. For Information:
1. Material Certificates: For site and street furnishings, signed by manufacturers.
 2. Maintenance Data: For site and street furnishings to include in maintenance manuals.

2.2 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of site and street furnishings through one source from a single manufacturer.

PART 2 - PRODUCTS

3.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Bicycle Rack –Campus Standard
 - a. Manufacturer: Dero Bike Rack Co.
 - b. Model: Hoop Rack.
 - c. Finish: Hot-Dipped Galvanized Finish with Powder Coat.
 - c. Color: Black
 - d. Mounting: Surface expansion bolt.

1.1 FABRICATION

- A. As per manufacturers' specifications.

1.2 FINISHES, GENERAL

- 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: 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.

1.3 STEEL AND GALVANIZED STEEL FINISHES

- A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester-TGIC, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

2.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance.
- B. Confirm that all products required and as noted meet the current university design standards.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

2.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written installation instructions, unless more stringent requirements are indicated. Complete field assembly of site and street furnishings, where required.
- B. Unless otherwise indicated, install site and street furnishings after landscaping and paving have been completed.

- C. Install site and street furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

2.3 CLEANING

- A. After completing site and street furnishing installation, inspect components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

END OF SECTION

SECTION 14 2400
HYDRAULIC ELEVATORS

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 hydraulic passenger elevators.
- B. Related Requirements:
 - 1. Section 01 5000 "Temporary Facilities and Controls" for temporary use of elevators for construction purposes.
 - 2. Section 03 3000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
 - 3. Section 04 2000 "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry and for grouting elevator entrance frames installed in masonry walls.
 - 4. Section 05 1200 "Structural Steel Framing" for the following:
 - a. Attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.
 - b. Divider beams.
 - c. Hoist beams.
 - d. Structural-steel shapes for subsills that are part of steel frame.
 - 5. Section 05 5000 "Metal Fabrications" for the following:
 - a. Attachment plates and angle brackets for supporting guide-rail brackets.
 - b. Divider beams.
 - c. Hoist beams.
 - d. Structural-steel shapes for subsills.
 - e. Pit ladders.
 - f. Cants in hoistways made from steel sheet.
 - 6. Section 09 9123 "Interior Painting" for field painting of hoistway entrance doors and frames.
 - 7. Section 22 1429 "Sump Pumps" for sump pumps, sumps, and sump covers in elevator pits.
 - 8. Section 27 1500 "Communications Horizontal Cabling" for telephone service for elevators.
 - 9. Section 28 3111 "Digital, Addressable Fire-Alarm System" 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.

1.3 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.

1.4 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, and 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Seismic Qualification Certificates: For elevator equipment, 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. 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.
- D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include diagnostic and repair information available to manufacturer's and Installer's maintenance personnel.
 - 2. If any diagnostic tool or equipment is required to set up, adjust, or troubleshoot the system, or any part of the system, provide one of each of these tools or equipment with each elevator including complete instructions for its use.

3. Prior to initialization of Work, provide three complete sets of wiring and single line diagrams showing the electrical connections, functions, components, and sequence of operations of all apparatus connected with the elevator system.
4. Provide three complete sets of neatly bound operating and maintenance instructions specifically for elevator installations.
 - a. The maintenance instructions shall include detailed information, with sufficient illustrations to prevent misinterpretation
 - b. The maintenance instructions shall include complete detailed data sufficient to adequately service the entire system, troubleshoot, repair, and order replacement parts.
 - c. Each Manual shall also contain a copy of the instructions and programs required to install, setup, and adjust the elevator system or any part of the system, including passwords of all levels.

- 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.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Elevator manufacturer or an authorized representative who is trained and approved by manufacturer.

1.8 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.

1.9 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 relating 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.

1.10 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: 2 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 General: Paint interior of each elevator shaft from the top of shaft down to the highest hoistway entrance sill, and from the elevator pit up to the head of the first opening white as indicated on Drawings. See Division 09 Painting Sections for product and installation requirements.

2.2 MANUFACTURERS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide 3500# HydroFit (holeless hydraulic) by Otis or a comparable product by one of the following:
 1. **KONE Inc.**
 2. **Schindler Elevator Corp**
 3. **ThyssenKrupp Elevator.**
- 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, shall be manufactured by single manufacturer.

2.3 PERFORMANCE REQUIREMENTS

- A. **Regulatory Requirements:** Comply with ASME A17.1/CSA B44.
- B. **Accessibility Requirements:** Comply with Section 407 in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.
- C. **Seismic Performance:** Elevator system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and shall comply with elevator safety requirements for seismic risk Zone 2 or greater in ASME A17.1/CSA B44.

2.4 ELEVATORS

- A. **Elevator System, General:** Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturers' standard components shall be used, as included in standard elevator systems and as required for complete system.
- B. **Elevator Description:**
 1. Elevator Number(s):
 2. Type: Holeless.
 3. Rated Load: **3500 lb (1589 kg).**
 4. Rated Speed: **125 fpm (0.64 m/s).**
 5. Operation System: Single automatic.
 6. Auxiliary Operations:
 - a. Battery-powered lowering.
 - b. Nuisance call cancel.
 7. Security Features:
 - a. Card-access operation system

- b. Power and wiring required for security camera in elevator cab.
- c. Elevators shall be equipped with Viking Electronics E-1600-02A emergency telephone, or College standard emergency telephone
- 8. Car Enclosures: Steel framed with nonremovable wall panels.
 - a. Front Walls (Return Panels): Stainless steel.
 - b. Side and Rear Wall Panels: Plastic laminate.
 - c. Doors: Stainless steel.
 - d. Ceiling: Luminous ceiling.
 - e. Handrails: Stainless steel.
 - f. Floor: Prepared to receive stone or ceramic tile.
- 9. Hoistway Entrances:
 - a. Width: 48 inches (1219 mm).
 - b. Height: 84 inches (2134 mm).
 - c. Type: Single-speed side sliding.
 - d. Frames: Stainless steel.
 - e. Doors: Stainless steel.
 - f. Sills: Nickel silver.
- 10. Hall Fixtures: Satin stainless steel, No. 4 finish
- 11. Additional Requirements:
 - a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.
 - b. Provide hooks for protective pads and one complete set(s) of full-height protective pads.

2.5 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 shall be submersible type with submersible squirrel-cage induction motor, and shall be suspended inside oil tank from vibration isolation mounts or shall be tank-top-mounted type with fan-cooled, squirrel-cage induction motor, and shall be 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 shall have wye-delta or solid-state starting.
- B. Hydraulic Silencers: System shall have 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 shall be connected with dielectric couplings.
- D. Hydraulic Fluid: Nontoxic, biodegradable, fire-resistant fluid made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives and approved by elevator manufacturer for use with elevator equipment.
- E. 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.
- F. Car Frame and Platform: Welded steel units.
- G. Guides: Roller guides: Provide guides at top and bottom of car and counterweight frames.

2.6 OPERATION SYSTEMS

- A. General: Provide manufacturer's standard microprocessor operation system as required to provide type of operation indicated, including remote monitoring, independent service, firefighter's service, inspection, access, and automatic two-way leveling.
1. The system shall provide a comprehensive means to access the computer memory for diagnostic purposes and shall have permanent indicator to indicate important elevator statuses as an integral part of the controller.
 2. The remote monitoring system shall be capable of monitoring multiple elevators and/or groups or elevators simultaneously and each elevator or group of elevators shall be simultaneously monitored from at least two remote locations outside the building on campus.
 3. The remote monitoring system shall include a dial-in modem and software so the system may be monitored from an off-campus site
- B. The installer may either connect into an existing compatible campus-wide remote monitoring system or provide all labor and materials, including software, required to install a system compatible with their Controller.
- C. Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated:
1. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight can be adjusted.
- D. Security Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.
1. Card-Reader Operation: System uses card readers at car-control 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 as indicated for card reader in car.
 - a. Security access system equipment is not in the Contract.
 2. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at car-control stations. Key is removable only in deactivated position.
 - a. The Firefighter's Service key-switch shall be operated by the EPCO MFD-1 key and all other key-switches and locks shall be Best 7-pin cylinder key-switches and locks

2.7 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 shall cause doors to stop and reopen.
- B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

2.8 CAR ENCLOSURES

- A. General: Provide enameled-steel car enclosures to receive removable wall panels, with 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: Reinforced floor structure prepared to receive epoxy terrazzo
 2. Stainless-Steel Wall Panels: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
 3. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to manufacturer's standard honeycomb core with plastic-laminate panel backing and manufacturer's standard protective edge trim. Panels have a flame-spread index of 25 or less, when tested according to ASTM E 84. 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
 7. Sills: Stainless Steel with No. 4 finish, with grooved surface, ~~1/4-inch (6.4 mm)~~ Sills: Extruded metal, with grooved surface, ~~1/4 inch (6.4 mm)~~ thick.
 8. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.
 9. Ceilings in "(Metal) (Metallic-Finish, Plastic-Laminate) Ceiling" Subparagraph below are offered by some manufacturers. Before retaining options, verify availability with manufacturers.
 10. Handrails: Manufacturer's standard handrails, of shape, metal, and finish indicated.

2.9 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 shall accommodate hoistway wall construction.
 1. Where gypsum board wall construction is indicated, frames shall be self-supporting with reinforced head sections.
- B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies shall 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: 1-1/2 hours.
- C. Materials and Fabrication: Manufacturer's standards, but not less than the following:
 1. Enameled-Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected by Architect from manufacturer's full range.
 2. Steel Subframes: Formed from cold- or hot-rolled steel sheet, with factory-applied enamel finish or rust-resistant primer. Fabricate to receive applied finish as indicated.
 3. Star of Life Symbol: Identify emergency elevators with star of life symbol, not less than **3 inches (76 mm)** high, on both inside surfaces of hoistway door frames.
 4. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
 5. Sight Guards: Provide sight guards on doors matching door edges.
 6. Sills: Extruded metal, with grooved surface, ~~1/4 inch (6.4 mm)~~ thick.
 7. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M.

2.10 SIGNAL EQUIPMENT

- A. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements with long-life lamps and acrylic or other permanent, non-yellowing translucent plastic diffusers.
- 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.
- C. 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.
 - 1. Provide Talk-A-Phone EPT100E
- D. 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.
- E. Hall Push-Button Stations: Provide one hall push-button station at each landing.
 - 1. Provide Stainless Steel with No. 4 finish, vandal resistant 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.
- F. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide one of the following:
 - 1. Stainless Steel with no. 4 finish, vandal resistant, wall-mounted units, for mounting above entrance frames.
 - 2. Units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing.
- G. 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.
- H. 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. For each elevator, provide illuminated signals that indicate when they are operational and when they are at the designated emergency return level with doors open.
- I. 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.

2.11 FINISH MATERIALS

- A. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
- C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.
- D. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
- E. Stainless-Steel Bars: ASTM A 276, Type 304.
- F. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
- G. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500 or No. C77600.

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. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor and braced at intervals as needed to maintain alignment. Anchor cylinder guides at spacing needed to maintain alignment and avoid overstressing guides.
- B. 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.
- C. 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.
- D. Install piping above the floor, where possible. Install underground piping in casing.
- E. Lubricate operating parts of systems as recommended by manufacturers.

- F. 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.
- G. Leveling Tolerance: **1/4 inch (6 mm)**, up or down, regardless of load and travel direction.
- H. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
- I. Locate hall signal equipment for elevators as follows, unless otherwise indicated:
 - 1. Place hall lanterns either above or beside each hoistway entrance.
 - 2. 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: Limit temporary use for construction purposes to one elevator. 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 shall include 24 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 shall be manufacturer's authorized replacement parts and supplies.
1. Perform maintenance during normal working hours.
 2. Include 24-hour-per-day, 7-day-per-week emergency callback service with response time of two hours or less.

END OF SECTION

SECTION 21 0500

COMMON WORK RESULTS FOR FIRE SUPPRESSION

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. This Section includes references to Division 23 Sections for fire suppression common materials and methods, in lieu of repeating the same information in Division 21. Referenced sections apply to Division 21 – Fire Suppression, Division 22 – Plumbing, and Division 23 – Heating, Ventilation and Air Conditioning.
- B. Related Sections include the following:
 - 1. Refer to Division 23 Section “Common Work Results for Mechanical” for basic materials and methods.
 - 2. Refer to Division 23 Section “Hangers and Supports for Mechanical Piping and Equipment” for hangers and supports requirements.
 - 3. Refer to Division 23 Section “Mechanical Identification” for identification requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 21 0500

SECTION 21 1313

FIRE-SUPPRESSION 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. This Section includes the following new fire-suppression piping inside the building:
 - 1. Wet-pipe sprinkler systems.
- B. Related Sections include the following:
 - 1. Division 28 Section "Digital, Addressable Fire-Alarm System" for alarm devices not specified in this Section.
 - 2. Division 22 Section "Plumbing Specialties" for backflow preventers installed in fire suppression systems.

1.3 DEFINITIONS

- A. Underground Service-Entrance Piping: Underground service piping below the building.

1.4 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 PERFORMANCE REQUIREMENTS

- A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.
- B. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - 2. Sprinkler Occupancy Hazard Classifications:
 - a. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - b. General Storage Areas: Ordinary Hazard, Group 1.
 - c. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - d. Office and Public Areas: Light Hazard.
 - 3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm/sq. ft. over 1500-sq. ft. area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm/sq. ft. over 1500-sq. ft. area.

4. Maximum Protection Area per Sprinkler: Per UL listing.
5. 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.
6. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:
 - a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
 - b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.

1.6 SUBMITTALS

- A. Product Data: For the following:
 1. Piping materials, including dielectric fittings and sprinkler specialty fittings.
 2. Pipe hangers and supports.
 3. Valves, including listed fire-protection valves and specialty valves and trim.
 4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
 5. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
 6. Alarm devices, including electrical data.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Fire-hydrant flow test report.
- D. Approved Sprinkler Piping Drawings: Working plans shall be prepared according to NFPA 13, that have been approved by the State of Maryland Fire Marshal's office, the authority having jurisdiction (AHJ), including hydraulic calculations. Hydraulic calculations shall be performed for each floor area within the building to prove most remote and demanding area. Shop drawings shall indicate each area of each floor where calculations were performed. Calculations shall be submitted with the drawings.
- E. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be identified with the applicable product style or series number.
- F. Sprinklers shall be referred to on drawings, submittals, and other documentation by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designation shall not be allowed.
- G. Field Test Reports and Certificates: 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" and "Contractor's Material and Test Certificate for Underground Piping."

- H. Welding certificates.
 - I. Field quality-control test reports.
 - J. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.
- 1.7 QUALITY ASSURANCE
- A. Installer Qualifications:
 - 1. Installer shall have been engaged in the sprinkler industry for a minimum of five (5) consecutive years and be licensed by the Maryland State Fire Marshall's Office.
 - 2. Installer's responsibilities include designing, fabricating, and installing fire-suppression 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 or a minimum Level III NICET certified designer.
 - B. Manufacturer Qualifications:
 - 1. Each item of equipment shall be capable of performing its function over an extended period of time with a minimum of attention and maintenance. All equipment and material shall be constructed using new materials designed and built in accordance with the best practices of the industry. Each item of equipment shall be listed in the Underwriters Laboratories Fire Protection Equipment List or Factory Mutual Approval Guide. Each major item of equipment shall bear the manufacturer's name or trademark; serial number; U.L. or F.M. label; operating instructions and hydraulic characteristic conditions, etc., where applicable.
 - 2. The equipment and material manufacturers shall have been engaged in the sprinkler industry for a minimum of five (5) consecutive years. Equipment shall comply with the year edition of NFPA 13 which is applicable at the time within the State of Maryland the time of contract execution..
 - C. Installation shall comply with the year edition of NFPA 13 which is applicable at the time within the State of Maryland at the time of contract execution.
 - D. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - E. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.
 - F. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."

- G. Fire-Test-Response Characteristics: Piping and related materials installed in return-air plenum spaces shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. All piping installed in return-air plenum spaces shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.8 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies. All sprinkler heads installed in acoustical tile ceilings shall be located in the center of the tile.
- B. In architecturally sensitive areas, specific sprinkler head layouts are indicated on the architectural reflected ceiling plans that have been coordinated with light fixtures, diffusers, etc. If the indicated sprinkler head layout does not meet NFPA or the requirements of the local authority having jurisdiction, Contractor shall inform the Architect immediately before hydraulic calculations are performed so the Architect can develop a sprinkler head design that does meet applicable code and standard requirements.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, 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 on Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE AND FITTINGS

- A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 with factory- or field-formed threaded ends.
 - 1. Cast-Iron Threaded Flanges: ASME B16.1.
 - 2. Malleable-Iron Threaded Fittings: ASME B16.3.
 - 3. Gray-Iron Threaded Fittings: ASME B16.4.
 - 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
 - 5. Steel Threaded Couplings: ASTM A 865.
- B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795.

1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- C. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed, roll-grooved ends.
1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Victaulic Co. of America FireLock EZ Series 009N and 107N.
 - 2) Anvil International, Inc.
 - 3) Tyco Fire Suppression & Building Products .
 - b. Grooved-End Fittings: UL-listed, ASTM A-395, grade 65-45-15 and ASTM A-536, grade 65-45-12 ductile iron grooved end fittings designed for fire protection systems; OD matching steel pipe OD. In applicable sizes, short-pattern, with flow equal to standard pattern fittings.
 - c. Grooved-End Pipe-Couplings: UL-listed ASTM-A-395, grade 65-45-15 and ASTM A-536, grade 65-45-12 ductile iron installation ready rigid type coupling cast with angle-pattern bolt pads and gasket to provide system rigidity and support and hanging in accordance with NFPA 13. Gasket material shall be Grade "E" EPDM Type A. All joints shall be provided with zinc electroplated carbon steel nuts and bolts.
 - d. Couplings and fittings shall be by same manufacturer.
 - e. Gaskets shall be by same manufacturer as couplings.
 - f. Grooving tools shall be supplied by the same manufacturer as the grooved components.
 - g. Rigid couplings shall be fully installed at visual pad-to-pad offset contact. Tongue and recess couplings shall be allowed only with the use of a torque wrench.

2.3 SPRINKLER SPECIALTY FITTINGS

- A. Sprinkler specialty fittings shall be UL listed and/or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.
- B. Outlet Specialty Fittings:
1. Manufacturers:
 - a. Victaulic Co. of America, Style 920/920N.
 - b. Anvil International, Inc.
 - c. Tyco Fire Suppression & Building Products.
 2. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with gaskets, bolts and nuts, and threaded, locking-lug, or grooved outlets.
 3. Fittings that incorporate the use of a set screw or bolt tightened against a section of piping (i.e. snap-on and strapless outlet fittings) shall not be permitted.
- C. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
1. Manufacturers:
 - a. AGF Manufacturing Co.

- b. Central Sprinkler Corp.
- c. G/J Innovations, Inc.
- d. Triple R Specialty of Ajax, Inc.

D. Drop-Nipple Fittings shall not be permitted.

2.4 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

B. Check Valves NPS 2 and Larger: UL 312, spring-assisted swing type for vertical or horizontal installation, cast or ductile iron body with flanged or grooved ends.

1. Manufacturers:

- a. Victaulic Co. of America Series #717.
- b. Kennedy Valve; a division of McWane, Inc.
- c. Reliable Automatic Sprinkler Co., Inc.
- d. Tyco Fire Suppression & Building Products.
- e. NIBCO Inc.
- f. Milwaukee Valve Co.

C. Gate Valves: UL 262, OS&Y type.

1. NPS 2 and Smaller: Bronze body with threaded ends.

a. Manufacturers:

- 1) Crane Co.; Crane Valve Group; Crane Valves.
- 2) Hammond Valve.
- 3) United Brass Works, Inc.
- 4) Milwaukee Valve Co.
- 5) NIBCO Inc.
- 6) Tyco Fire & Building Products LP.

2. NPS 2-1/2 and Larger: Cast ductile-iron body with grooved or flanged ends.

a. Manufacturers:

- 1) Victaulic Company, Series 771.
- 2) Crane Co.; Crane Valve Group; Crane Valves.
- 3) Hammond Valve.
- 4) Milwaukee Valve Company.
- 5) NIBCO Inc.
- 6) Tyco Fire & Building Products LP.
- 7) United Brass Works.

D. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.

- 1. Indicator: Weatherproof actuator housing, with electrical, 125-V ac, prewired, single-circuit, supervisory switches or Electrical, 115-V ac, prewired, 2-circuit, supervisory switch.
- 2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.

- a. Manufacturers:
 - 1) Victaulic Co. of America, Series #728.
 - 2) Milwaukee Valve Company.
3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends. Valve seat shall be pressure responsive and the stem offset from the disc centerline to provide complete 360-degree circumferential seating.
 - a. Manufacturers:
 - 1) Victaulic Co. of America Series #705.
 - 2) Tyco Fire Suppression & Building Products
 - 3) McWane, Inc.; Kennedy Valve Div.
 - 4) Milwaukee Valve Company.

2.5 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing and/or FM Global's "Approval Guide."
2. Pressure Rating:
 - a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.
6. Manufacturers: Subject to compliance with requirements provide products by one of the following:
 - a. Victaulic Co. of America.
 - b. Tyco Fire Suppression & Building Products.
 - c. Reliable Automatic Sprinkler Co.
 - d. Viking Corporation.

B. Alarm Valves:

1. Standard: UL 193.
2. Design: For vertical installation.
3. Valve internal components shall be replaceable with valve in the installed position.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
7. Basis of Design: Victaulic Series 751.

2.6 SPRINKLERS

- A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating.
- B. Sprinklers shall be glass bulb type, with hex shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation. (Wrenches shall be provided by

the sprinkler manufacturer that directly engage the cast wrench boss.) Basis of Design: Victaulic.

C. Manufacturers:

1. Victaulic Co. of America.
2. Tyco Fire Suppression & Building Products
3. Reliable Automatic Sprinkler Co., Inc.
4. Viking Corp.

D. Automatic Sprinklers: With heat-responsive element complying with the following:

1. UL 199, for nonresidential applications.

E. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.

F. Sprinkler types, features, and options as follows (all sprinklers to be quick response type):

1. Concealed ceiling sprinklers, including cover plate.
2. Pendent sprinklers.
3. Recessed sprinklers, including escutcheon.
4. Sidewall sprinklers.
5. Upright sprinklers.

G. Sprinkler Finishes: **[Bronze] [and] factory [custom color] painted. <Coordinate custom paint colors with Architect for each space.>**

H. Special Coatings: Nickel-Teflon, Wax, lead, and corrosion-resistant paint.

I. 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: Steel, 2 piece, factory painted adjustable, **[white] [or] [custom color]** finish.
2. Sidewall Mounting: Steel, 2-piece, adjustable, factory painted **[white] [or] [custom color]** finish.

J. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

K. Escutcheons and guards shall be listed, and supplied for use with the sprinkler by the sprinkler manufacturer.

2.7 FIRE DEPARTMENT CONNECTIONS

A. Manufacturers:

1. Tyco Fire Suppression & Building Products
2. Elkhart Brass Mfg. Co., Inc.
3. Fire-End and Croker Corp.
4. Guardian Fire Equipment Incorporated.

5. Potter-Roemer; Fire-Protection Div.
 6. Reliable Automatic Sprinkler Co., Inc.
- B. Exposed, Freestanding-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body, brass inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, and bottom outlet with pipe threads. Include brass lugged caps, gaskets, and brass chains; brass lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch-high, brass sleeve; and round, floor, brass escutcheon plate with marking "AUTO SPKR."
1. Finish Including Sleeve: Polished chrome-plated.
- C. At the low point near each fire department connection, provide a 90-degree elbow with drain connection to allow for localized system drainage to prevent freezing. Basis of Design: Victaulic FireLock #10-DR.

2.8 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Electrically Operated Alarm: UL 464, with 10-inch- diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.
1. Manufacturers:
 - a. Potter Electric Signal Company.
 - b. System Sensor.
- C. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
1. Manufacturers:
 - a. McWane, Inc.; Kennedy Valve Div.
 - b. Potter Electric Signal Company.
 - c. System Sensor.
- D. Zone Control Riser Assembly: Product shall be fully integrated one piece cast ductile iron and factory assembled that contains the following appurtenances: Water flow switch, alarm connection, pressure gage and inspector test and drain connection with site glass.
1. Manufacturers:
 - a. Victaulic Co. of America, Series 747M.
 - b. Tyco Fire Suppression & Building Products.
 - c. Viking Corp.
 - d. Reliable Automatic Sprinkler Co., Inc.
 2. Where required all components shall be listed for vertical installation.

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 Part 1 "Quality Assurance" Article.
 - 1. Report test results promptly and in writing. Submit results with shop drawing review documents.

3.2 EXAMINATION

- A. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PIPING APPLICATIONS, GENERAL

- A. Shop weld pipe joints where welded piping is indicated.
- B. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- C. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints. Underground connections shall use restrained mechanical joint ductile iron pipe and fittings.
- D. Underground Service-Entrance Piping: Ductile-iron, cement-lined mechanical-joint pipe and fittings and restrained joints

3.4 SPRINKLER SYSTEM PIPING APPLICATIONS

- A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:
 - 1. Sprinkler-Piping Fitting Option: Specialty sprinkler fittings, NPS 2 and smaller, including mechanical-T and -cross fittings, may be used downstream from sprinkler zone valves.
 - 2. NPS 1-1/2 and Smaller: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 - 3. NPS 1-1/2 and Smaller (Contractor's Option): Plain-end, black, standard-weight steel pipe; steel welding fittings; and welded joints.
 - 4. NPS 2 and Larger: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 - 5. NPS 2 and Larger (Contractor's Option): Plain-end, black, standard-weight steel pipe; steel welding fittings; and welded joints.
 - 6. NPS 2 and Larger, Not Exposed in Finished Spaces (Contractor's Option): Grooved-end, black, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

3.5 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA.
 - a. Shutoff Duty: Use ball, butterfly, or gate valves.

3.6 JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Common Work Results for Mechanical" for basic piping joint construction.
- B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.
- C. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts in accordance with the manufacturer's latest published installation instructions.
 - 1. Steel Pipe: Roll-groove piping. Use grooved-end fittings and grooved-end-pipe couplings, unless otherwise indicated.
 - 2. UL listed and FM approved.
 - 3. All grooved piping components shall be the product of a single manufacturer.
 - 4. All gasketed joints shall incorporate an integral pipe stop type gasket.
 - 5. Gasket material shall be Grade "E" EPDM (Type A) rubber.
 - 6. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to (and including) groove.
 - 7. Gasket shall be manufactured by the coupling manufacturer and verified as suitable for the intended service.
 - 8. A factory trained representative (direct employee) of the coupling manufacturer shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. The representative shall periodically visit the job site and review installation to ensure best practices in grooved joint installation are being followed. Contractor shall remove and replace any improperly installed products.

3.7 SERVICE-ENTRANCE PIPING

- A. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to fire-service piping.

3.8 PIPING INSTALLATION

- A. Refer to Division 23 Section "Common Work Results for Mechanical" for basic piping installation.
- B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

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.
- C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
- E. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.
- F. Unions and flanges for servicing and disconnect are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as disconnect points if required.)
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
- K. Install alarm devices in piping systems.
- L. Hangers and Supports: Comply with NFPA 13 for hanger materials.
 1. Install sprinkler system piping according to NFPA 13.
- M. Install pressure gages on riser or feed main and at each sprinkler test connection. 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 will not be subject to freezing.
- N. Fill wet-pipe sprinkler system piping with water.

3.9 VALVE INSTALLATION

- A. Install listed fire-protection valves, unlisted general-duty 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. Specialty Valves:

1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.

3.10 SPRINKLER APPLICATIONS

A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Acoustic Tile Ceiling: Recessed pendent.
3. Rooms with Gypsum Wallboard Ceiling: **Concealed** sprinklers.
4. Wall Mounting: Recessed Sidewall sprinklers.

5. Sprinkler Finishes:

- a. Upright In Finished Spaces Exposed to View: Factory painted custom color, coordinate custom color for each space with Architect.
- b. Upright and Pendent Sprinklers In Mechanical/Electrical Equipment Rooms and Unfinished Spaces Not Exposed to View: Rough bronze.
- c. Recessed Pendent Sprinklers:
 - 1) Factory painted white with matching escutcheon in acoustical tile lay-in ceilings.
 - 2) Factory painted **[white] [custom color]** with matching escutcheon in gypsum wallboard ceilings.
- d. Recessed Sidewall Sprinklers: Factory painted custom color, coordinate custom color for each space with Architect.
- e. Concealed Pendent Sprinklers:
 - 1) Factory painted white cover plate in acoustical tile lay-in ceilings.
 - 2) Factory painted **[white] [custom color]** cover plate in gypsum wallboard ceilings.

3.11 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles.
- B. Sprinklers that may be subject to mechanical damage due to their location (low hanging sprinklers, under ducts, stairs, equipment, gratings, etc.) shall be provided with guards.
- C. The sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.
- D. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.
- E. Sprinkler bulb protector shall be removed by hand after installation. Do not use tools or any other device(s) to remove the protector that could damage the bulb in any way.

3.12 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install freestanding-type, fire department connections in level surface.
- B. Install ball drip valve at each check valve for fire department connection.

3.13 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Plumbing Specialties" for backflow preventers.
- D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
- E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
- F. Electrical Connections: Power wiring is specified in Division 26.
- G. Connect alarm devices to fire alarm.
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- J. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.14 LABELING AND IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and in Division 23 Section "Identification for Mechanical."

3.15 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 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. Energize circuits to electrical equipment and devices.
 - 4. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.

5. Coordinate with fire alarm tests. Operate as required.
6. Verify that equipment hose threads are same as local fire department equipment.

B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.16 CLEANING AND PROTECTION

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.
- C. Protect sprinklers from damage until Substantial Completion.

3.17 DEMONSTRATION [COMMISSIONING]

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01 Section "Demonstration and Training."
- B. Upon commissioning of the specialty and pre-action systems, the contractor shall engage a factory trained field representative to train contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products. A follow-up letter shall be written by the manufacturer after completion when multiple systems are installed.

END OF SECTION 211313

SECTION 22 0500

COMMON WORK RESULTS FOR PLUMBING

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. This Section includes references to Division 23 Sections for plumbing common materials and methods, in lieu of repeating the same information in Division 22. Referenced sections apply to Division 21 – Fire Suppression, Division 22 – Plumbing, and Division 23 – Heating, Ventilation and Air Conditioning.

- B. Related Sections include the following:

1. Refer to Division 23 Section “Common Work Results for Mechanical” for basic materials and methods.
2. Refer to Division 23 Section “Common Motor Requirements for Mechanical Equipment” for motor requirements.
3. Refer to Division 23 Section “Meters and Gages for Mechanical Piping” for meters and gages requirements.
4. Refer to Division 23 Section “General-Duty Valves for Mechanical Piping” for valve requirements.
5. Refer to Division 23 Section “Hangers and Supports for Mechanical Piping and Equipment” for hangers and supports requirements.
6. Refer to Division 23 Section “Mechanical Vibration Control” for vibration isolation requirements.
7. Refer to Division 23 Section “Identification for Mechanical” for identification requirements.
8. Refer to Division 23 Section “Mechanical Insulation” for insulation requirements.
9. Refer to Division 23 Section “Instrumentation and Controls for HVAC” for requirements for monitoring and controlling of Plumbing systems.
10. Refer to Division 23 Section “Sequence of Operations for HVAC Controls” for monitoring and controlling of Plumbing systems.
11. Refer to Section 019100 “General Commissioning Requirements” and Section 220800 “Plumbing Systems Commissioning” for requirements associated with Commissioning.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 22 0500

SECTION 221113 - FACILITY WATER DISTRIBUTION 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. This Section includes water-distribution piping and related components outside the building for combined water service and fire-service mains.
- B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.3 DEFINITIONS

- A. EPDM: Ethylene propylene diene terpolymer rubber.
- B. LLDPE: Linear, low-density polyethylene plastic.
- C. PA: Polyamide (nylon) plastic.
- D. PE: Polyethylene plastic.
- E. PP: Polypropylene plastic.
- F. PVC: Polyvinyl chloride plastic.
- G. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
- H. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
 - 1. Wiring Diagrams: Power, signal, and control wiring for alarms.

1.5 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 test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
 - 2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
 - 3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- 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 ASTM F 645 for selection, design, and installation of thermoplastic water piping.
- E. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- F. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- G. NSF Compliance:
 - 1. Comply with NSF 14 for plastic potable-water-service piping.
 - 2. Comply with NSF 61 Annex G for materials for water-service piping and specialties for domestic water.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
 - 1. Ensure that valves are dry and internally protected against rust and corrosion.

2. Protect valves against damage to threaded ends and flange faces.
 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, including 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 valves and fire hydrants if size requires handling by crane or lift. Rig valves 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.

1.9 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 according to requirements indicated:
1. Notify Owner no fewer than two days in advance of proposed interruption of service.
 2. Do not proceed with interruption of water-distribution service without Owner's written permission.

1.10 COORDINATION

- A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.

1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
 2. Copper, Pressure-Seal Fittings:
 - a. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
 - b. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
- B. Hard Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B), water tube, drawn temper.
1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
 2. Copper, Pressure-Seal Fittings:
 - a. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
 - b. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
- C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
- D. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Gaskets: AWWA C111, rubber.
- C. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.
1. Grooved-End, Ductile-Iron Pipe Appurtenances:

- a. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
 - b. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
- D. Flanges: ASME 16.1, Class 125, cast iron.

2.3 PE PIPE AND FITTINGS

- A. PE, ASTM Pipe: ASTM D 2239, SIDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than 200 psig (1380 kPa).
- 1. Insert Fittings for PE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
 - 2. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.
- B. PE, AWWA Pipe: AWWA C906, DR No. 7.3, 9, or 9.3; with PE compound number required to give pressure rating not less than 200 psig (1380 kPa).
- 1. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than 200 psig (1380 kPa).
- C. PE, Fire-Service Pipe: ASTM F 714, AWWA C906, or equivalent for PE water pipe; FMG approved, with minimum thickness equivalent to FMG Class 200.
- 1. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

2.4 PVC PIPE AND FITTINGS

- A. PVC, Schedule 40 Pipe: ASTM D 1785.
- 1. PVC, Schedule 40 Socket Fittings: ASTM D 2466.
- B. PVC, Schedule 80 Pipe: ASTM D 1785.
- 1. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
 - 2. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.
- C. PVC, AWWA Pipe: AWWA C900, Class 200, with bell end with gasket, and with spigot end.
- 1. Comply with UL 1285 for fire-service mains if indicated.
 - 2. PVC Fabricated Fittings: AWWA C900, Class 200, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - 3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.

4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Gaskets: AWWA C111, rubber.
5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.5 FIBERGLASS PIPE AND FITTINGS

- A. AWWA RTRP: AWWA C950, Class 200, Type I, Grade 1, epoxy, with bell-and-spigot ends for bonded joints. Liner is optional, unless otherwise indicated.
 1. RTRF: AWWA C950, similar to pipe in material, pressure class, and joining method.
- B. UL RTRP: UL 1713, Class 200, with bell-and-spigot ends with gasket or seal for gasketed joints. Liner is optional, unless otherwise indicated.
 1. RTRF: Similar to pipe in material, pressure class, and joining method.

2.6 SPECIAL PIPE FITTINGS

- A. Ductile-Iron Rigid Expansion Joints:
 1. Description: Three-piece, ductile-iron assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - a. Pressure Rating: 250 psig (1725 kPa) minimum.
- B. Ductile-Iron Flexible Expansion Joints:
 1. Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - a. Pressure Rating: 250 psig (1725 kPa) minimum.
- C. Ductile-Iron Deflection Fittings:
 1. Description: Compound, ductile-iron coupling fitting with sleeve and 1 or 2 flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - a. Pressure Rating: 250 psig (1725 kPa) minimum.

2.7 JOINING MATERIALS

- A. Refer to Section 330500 "Common Work Results for Utilities" for commonly used joining materials.
- B. Brazing Filler Metals: AWS A5.8, BCuP Series.
- C. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.
- D. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.8 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.
- B. Tubular-Sleeve Pipe Couplings:
 - 1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
 - a. Standard: AWWA C219.
 - b. Center-Sleeve Material: Manufacturer's standard Gasket Material: Natural or synthetic rubber.
 - c. Pressure Rating: 200 psig (1380 kPa) minimum.
 - d. Metal Component Finish: Corrosion-resistant coating or material.
- C. Split-Sleeve Pipe Couplings:
 - 1. Description: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.
 - a. Standard: AWWA C219.
 - b. Sleeve Material: Manufacturer's standard
 - c. Sleeve Dimensions: Of thickness and width required to provide pressure rating.
 - d. Gasket Material: O-rings made of EPDM rubber, unless otherwise indicated.
 - e. Pressure Rating: 200 psig (1380 kPa) minimum.
 - f. Metal Component Finish: Corrosion-resistant coating or material.
- D. Flexible Connectors:
 - 1. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
 - 2. Ferrous-Metal Piping: Stainless-steel hose covered with stainless-steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.
- E. 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 (1035 kPa)
 - 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 (1035 kPa)
 - 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) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig (1035 kPa)
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel backing washers.
5. Dielectric Nipples:
 - a. Description:
 - 1) Standard: IAPMO PS 66
 - 2) Electroplated steel nipple complying with ASTM F 1545.
 - 3) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
 - 4) End Connections: Male threaded or grooved.
 - 5) Lining: Inert and noncorrosive, propylene.

2.9 CORROSION-PROTECTION PIPING ENCASUREMENT

A. Encasement for Underground Metal Piping:

1. Standards: ASTM A 674 or AWWA C105.
2. Form: Tube.
3. Material: LLDPE film of 0.008-inch (0.20-mm) minimum thickness.
4. Material: LLDPE film of 0.008-inch (0.20-mm) minimum thickness, or high-density, crosslaminated PE film of 0.004-inch (0.10-mm) minimum thickness.

5. Material: High-density, crosslaminated PE film of 0.004-inch (0.10-mm) minimum thickness.
6. Color: Black.

2.10 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:

1. Nonrising-Stem, Metal-Seated Gate Valves:

- a. Description: Gray- or ductile-iron body and bonnet; with cast-iron or bronze double-disc gate, bronze gate rings, bronze stem, and stem nut.

- 1) Standard: AWWA C500.
- 2) Minimum Pressure Rating: 200 psig (1380 kPa).
- 3) End Connections: Mechanical joint.
- 4) Interior Coating: Complying with AWWA C550.

2. Nonrising-Stem, Resilient-Seated Gate Valves:

- a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.

- 1) Standard: AWWA C509.
- 2) Minimum Pressure Rating: 200 psig (1380 kPa).
- 3) End Connections: Mechanical joint.
- 4) Interior Coating: Complying with AWWA C550.

3. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:

- a. Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.

- 1) Standard: AWWA C509.
- 2) Minimum Pressure Rating: 250 psig (1725 kPa).
- 3) End Connections: Push on or mechanical joint.
- 4) Interior Coating: Complying with AWWA C550.

4. OS&Y, Rising-Stem, Metal-Seated Gate Valves:

- a. Description: Cast- or ductile-iron body and bonnet, with cast-iron double disc, bronze disc and seat rings, and bronze stem.

- 1) Standard: AWWA C500.
- 2) Minimum Pressure Rating: 200 psig (1380 kPa).
- 3) End Connections: Flanged.

5. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:

- a. Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.

- 1) Standard: AWWA C509.
- 2) Minimum Pressure Rating: 200 psig (1380 kPa).
- 3) End Connections: Flanged.

B. UL/FMG, Cast-Iron Gate Valves:

1. UL/FMG, Nonrising-Stem Gate Valves:

- a. Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.

- 1) Standards: UL 262 and FMG approved.
- 2) Minimum Pressure Rating: 175 psig (1207 kPa).
- 3) End Connections: Flanged.

2. OS&Y, Rising-Stem Gate Valves:

- a. Description: Iron body and bonnet and bronze seating material.

- 1) Standards: UL 262 and FMG approved.
- 2) Minimum Pressure Rating: 175 psig (1207 kPa).
- 3) End Connections: Flanged.

C. Bronze Gate Valves:

1. OS&Y, Rising-Stem Gate Valves:

- a. Description: Bronze body and bonnet and bronze stem.

- 1) Standards: UL 262 and FMG approved.
- 2) Minimum Pressure Rating: 175 psig (1207 kPa).
- 3) End Connections: Threaded.

2. Nonrising-Stem Gate Valves:

- a. Description: Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable-iron handwheel.

- 1) Standard: MSS SP-80.

2.11 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Description: Sleeve and valve compatible with drilling machine.

- a. Standard: MSS SP-60.
- b. 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.
- c. 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 (125 mm) 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, FMG-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.

2.12 CHECK VALVES

- A. AWWA Check Valves:
 - 1. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.
 - a. Standard: AWWA C508.
 - b. Pressure Rating: 175 psig (1207 kPa).
- B. UL/FMG, Check Valves:
 - 1. Description: Swing-check type with pressure rating; rubber-face checks, unless otherwise indicated; and ends matching piping.
 - a. Standards: UL 312 and FMG approved.
 - b. Pressure Rating: 175 psig (1207 kPa).

2.13 DETECTOR CHECK VALVES

- A. Detector Check Valves:
 - 1. Description: Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.
 - a. Standards: UL 312 and FMG approved.
 - b. Pressure Rating: 175 psig (1207 kPa).
 - c. Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.
 - 2. Description: Iron body, corrosion-resistant clapper ring and seat ring material, flanged ends, with connections for bypass and installation of water meter.
 - a. Standards: UL 312 and FMG approved.
 - b. Pressure Rating: 175 psig (1207 kPa).

2.14 BUTTERFLY VALVES

- A. AWWA Butterfly Valves:
 - 1. Description: Rubber seated.
 - a. Standard: AWWA C504.
 - b. Body: Cast or ductile iron.
 - c. Body Type: [Wafer] [Wafer or flanged] [Flanged].
 - d. Pressure Rating: 150 psig (1035 kPa).
- B. UL Butterfly Valves:
 - 1. Description: Metal on resilient material seating.
 - a. Standards: UL 1091 and FMG approved.
 - b. Body: Cast or ductile iron.
 - c. Body Type: [Wafer] [Wafer or flanged] [Flanged].
 - d. Pressure Rating: 175 psig (1207 kPa).

2.15 PLUG VALVES

- A. Plug Valves:
 - 1. Description: Resilient-seated eccentric.
 - a. Standard: MSS SP-108.
 - b. Body: Cast iron.
 - c. Pressure Rating: 175-psig (1207-kPa) minimum CWP.
 - d. Seat Material: Suitable for potable-water service.

2.16 CORPORATION VALVES AND CURB VALVES

- A. Manufacturers:
 - 1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
- B. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.
 - 1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
 - 2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
 - 3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.
- C. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.
- D. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug

with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches (75 mm) in diameter.

1. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

2.17 WATER METERS

A. Water meters will be furnished by utility company.

B. Displacement-Type Water Meters:

1. Description: With bronze main case.
 - a. Standard: AWWA C700.
 - b. Registration: Flow in gallons (liters).

C. Turbine-Type Water Meters:

1. Description:
 - a. Standard: AWWA C701.
 - b. Registration: Flow in gallons (liters).

D. Compound-Type Water Meters:

1. Description:
 - a. Standard: AWWA C702.
 - b. Registration: Flow in gallons (liters).

E. Remote Registration System:

1. Description: Utility company standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
 - a. Standard: AWWA C706.
 - b. Registration: Flow in gallons (liters).

F. Remote Registration System:

1. Description: Utility company standard; encoder type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
 - a. Standard: AWWA C707.
 - b. Registration: Flow in gallons (liters).
 - c. Data-Acquisition Units: Comply with utility company requirements for type and quantity.
 - d. Visible Display Units: Comply with utility company requirements for type and quantity.

2.18 DETECTOR-TYPE WATER METERS

- A. Description: Main line, proportional meter with second meter on bypass. Register flow in gallons (liters).
1. Standards: AWWA C703, UL listed, and FMG approved.
 2. Pressure Rating: 150 psig (1035 kPa).
 3. Bypass Meter: AWWA C701, turbine-type, bronze case.
 - a. Size: At least one-half nominal size of main-line meter.
- B. Description: Main-line turbine meter with strainer and second meter on bypass. Register flow in gallons (liters).
1. Standards: AWWA C703, UL listed, and FMG approved.
 2. Pressure Rating: 175 psig (1207 kPa).
 3. Bypass Meter: AWWA C701, turbine-type, bronze case.
 - a. Size: At least NPS 2 (DN 50).
- C. Remote Registration System:
1. Description: Utility company standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
 - a. Standard: AWWA C706.
 - b. Registration: Flow in gallons (liters).
- D. Remote Registration System:
1. Description: Utility company standard; encoder type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
 - a. Standard: AWWA C707.
 - b. Registration: Flow in gallons (liters).
 - c. Data-Acquisition Units: Comply with utility company requirements for type and quantity.
 - d. Visible Display Units: Comply with utility company requirements for type and quantity.

2.19 PRESSURE-REDUCING VALVES

- A. Water Regulators:
1. Standard: ASSE 1003.
 2. Pressure Rating: Initial pressure of 150 psig (1035 kPa).
 3. Size: <Insert NPS (DN)>.
 4. Design Flow Rate: <Insert gpm (L/s)>.
 5. Design Inlet Pressure: <Insert psig (kPa)>.
 6. Design Outlet Pressure Setting: <Insert psig (kPa)>.

7. Body: Bronze with chrome-plated finish for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved] for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
8. Valves for Booster Heater Water Supply: Include integral bypass.
9. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

B. Water Control Valves:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Description: Pilot-operation, diaphragm-type, single-seated main water control valve with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.
 - a. Pressure Rating: Initial pressure of 150 psig (1035 kPa) minimum.
 - b. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
 - 1) Size: <Insert NPS (DN)>.
 - 2) Pattern: [Angle] [Globe]-valve design.
 - 3) Trim: Stainless steel.
 - c. Design Flow Rate: <Insert gpm (L/s)>.
 - d. Design Inlet Pressure: <Insert psig (kPa)>.
 - e. Design Outlet Pressure Setting: <Insert psig (kPa)>.
 - f. End Connections: Threaded for NPS 2 (DN 50) and smaller; [flanged] <Insert type> for NPS 2-1/2 (DN 65) and larger.

2.20 RELIEF VALVES

A. Air-Release Valves:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Description: Hydromechanical device to automatically release accumulated air.
 - a. Standard: AWWA C512.
 - b. Pressure Rating: [300 psig (2070 kPa)] <Insert pressure>.
 - c. Body Material: [Cast iron] <Insert material>.
 - d. Trim Material: Stainless steel[, brass, or bronze].
 - e. Water Inlet Size: <Insert NPS (DN)>.
 - f. Air Outlet Size: <Insert NPS (DN)>.
 - g. Orifice Size: <Insert inch (mm)>.
 - h. Design Air-Release Capacity: <Insert cfm (L/s)> at <Insert psig (kPa)> pipeline pressure.

B. Air/Vacuum Valves:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Description: Direct-acting, float-operated, hydromechanical device with large orifice to automatically release accumulated air or to admit air during filling of piping.

- a. Standard: AWWA C512.
- b. Pressure Rating: [300 psig (2070 kPa)] <Insert pressure>.
- c. Body Material: [Cast iron] <Insert material>.
- d. Trim Material: Stainless steel[, brass, or bronze].
- e. Inlet and Outlet Size: <Insert NPS (DN)>.
- f. Orifice Size: <Insert inch (mm)>.
- g. Design Air Capacity: <Insert cfm (L/s)> at <Insert psig (kPa)> differential pressure.

C. Combination Air Valves:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Description: Float-operated, hydromechanical device to automatically release accumulated air or to admit air.
 - a. Standard: AWWA C512.
 - b. Pressure Rating: [300 psig (2070 kPa)] <Insert pressure>.
 - c. Body Material: [Cast iron] <Insert material>.
 - d. Trim Material: Stainless steel[, brass, or bronze].
 - e. Inlet and Outlet Size: <Insert NPS (DN)>.
 - f. Orifice Size: <Insert inch (mm)>.
 - g. Design Air Capacity: <Insert cfm (L/s)> at <Insert psig (kPa)> differential pressure.

2.21 VACUUM BREAKERS

A. Pressure Vacuum Breaker Assembly:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: [5 psig (35 kPa)] <Insert pressure> maximum, through middle 1/3 of flow range.
5. Size: <Insert NPS (DN)>.
6. Design Flow Rate: <Insert gpm (L/s)>.
7. Selected Unit Flow Range Limits: <Insert gpm (L/s)>.
8. Pressure Loss at Design Flow Rate: <Insert psig (kPa)>.
9. Accessories: Ball valves on inlet and outlet.

2.22 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Standard: [ASSE 1013] [or] [AWWA C511].
3. Operation: Continuous-pressure applications.
4. Pressure Loss: [12 psig (83 kPa)] <Insert pressure> maximum, through middle 1/3 of flow range.
5. Size: <Insert NPS (DN)>.

6. Design Flow Rate: <Insert gpm (L/s)>.
7. Selected Unit Flow Range Limits: <Insert gpm (L/s)>.
8. Pressure Loss at Design Flow Rate: <Insert psig (kPa)> for NPS 2 (DN 50) and smaller; <Insert psig (kPa)> for NPS 2-1/2 (DN 65) and larger.
9. Body: Bronze for NPS 2 (DN 50) and smaller; [cast iron with interior lining complying with AWWA C550 or that is FDA approved] [steel with interior lining complying with AWWA C550 or that is FDA approved] [stainless steel] for NPS 2-1/2 (DN 65) and larger.
10. End Connections: Threaded for NPS 2 (DN 50) and smaller; [flanged] <Insert type> for NPS 2-1/2 (DN 65) and larger.
11. Configuration: Designed for [horizontal, straight through] [vertical inlet, horizontal center section, and vertical outlet] [vertical] <Insert configuration> flow.
12. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

B. Double-Check, Backflow-Prevention Assemblies:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: [ASSE 1015] [or] [AWWA C510].
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: [5 psig (35 kPa)] <Insert pressure> maximum, through middle 1/3 of flow range.
5. Size: <Insert NPS (DN)>.
6. Design Flow Rate: <Insert gpm (L/s)>.
7. Selected Unit Flow Range Limits: <Insert gpm (L/s)>.
8. Pressure Loss at Design Flow Rate: <Insert psig (kPa)> for NPS 2 (DN 50) and smaller; <Insert psig (kPa)> for NPS 2-1/2 (DN 65) and larger.
9. Body: Bronze for NPS 2 (DN 50) and smaller; [cast iron with interior lining complying with AWWA C550 or that is FDA approved] [steel with interior lining complying with AWWA C550 or that is FDA approved] [stainless steel] for NPS 2-1/2 (DN 65) and larger.
10. End Connections: Threaded for NPS 2 (DN 50) and smaller; [flanged] <Insert type> for NPS 2-1/2 (DN 65) and larger.
11. Configuration: Designed for [horizontal, straight through] <Insert configuration> flow.
12. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

C. Reduced-Pressure-Detector, Fire-Protection Backflow Preventer Assemblies:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: ASSE 1047 and UL listed or FMG approved.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: [12 psig (83 kPa)] <Insert pressure> maximum, through middle 1/3 of flow range.
5. Size: <Insert NPS (DN)>.
6. Design Flow Rate: <Insert gpm (L/s)>.

7. Selected Unit Flow Range Limits: <Insert gpm (L/s)>.
8. Pressure Loss at Design Flow Rate: <Insert psig (kPa)>.
9. Body: [Cast iron with interior lining complying with AWWA C550 or that is FDA approved] [Steel with interior lining complying with AWWA C550 or that is FDA approved] [Stainless steel].
10. End Connections: Flanged.
11. Configuration: Designed for [horizontal, straight through] [vertical inlet, horizontal center section, and vertical outlet] [vertical] <Insert configuration> flow.
12. Accessories:
 - a. Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
 - c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

D. Double-Check, Detector-Assembly Backflow Preventers:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: ASSE 1048 and UL listed or FMG approved.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: [5 psig (35 kPa)] <Insert pressure> maximum, through middle 1/3 of flow range.
5. Size: <Insert NPS (DN)>.
6. Design Flow Rate: <Insert gpm (L/s)>.
7. Selected Unit Flow Range Limits: <Insert gpm (L/s)>.
8. Pressure Loss at Design Flow Rate: <Insert psig (kPa)>.
9. Body: [Cast iron with interior lining complying with AWWA C550 or that is FDA approved] [Steel with interior lining complying with AWWA C550 or that is FDA approved] [Stainless steel].
10. End Connections: Flanged.
11. Configuration: Designed for [horizontal, straight through] [vertical inlet, horizontal center section, and vertical outlet] [vertical] <Insert configuration> flow.
12. Accessories:
 - a. Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
 - b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

E. Backflow Preventer Test Kits:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.23 WATER METER BOXES

- A. Description: Cast-iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.
 - 1. Option: Base section may be cast-iron, PVC, clay, or other pipe.
- B. Description: Cast-iron body and double cover for disc-type water meter, with lettering "WATER METER" in top cover; and with separate inner cover; air space between covers; and slotted, open-bottom base section of length to fit over service piping.
- C. Description: Polymer-concrete body and cover for disc-type water meter, with lettering "WATER" in cover; and with slotted, open-bottom base section of length to fit over service piping. Include vertical and lateral design loadings of 15,000 lb minimum over 10 by 10 inches (6800 kg minimum over 254 by 254 mm) square.

2.24 CONCRETE VAULTS

- A. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857 and made according to ASTM C 858.
 - 1. Ladder: ASTM A 36/A 36M, steel or polyethylene-encased steel steps.
 - 2. Manhole: ASTM A 48/A 48M Class No. 35A minimum tensile strength, gray-iron traffic frame and cover.
 - a. Dimension: 24-inch (610-mm) minimum diameter, unless otherwise indicated.
 - 3. Manhole: ASTM A 536, Grade 60-40-18, ductile-iron traffic frame and cover.
 - a. Dimension: 24-inch- (610-mm-) minimum diameter, unless otherwise indicated.
 - 4. Drain: ASME A112.6.3, cast-iron floor drain with outlet of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

2.25 PROTECTIVE ENCLOSURES

- A. Freeze-Protection Enclosures:
 - 1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
 - 2. Description: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of 40 deg F (4 deg C) when external temperatures reach as low as minus 34 deg F (minus 36 deg C).
 - a. Standard: ASSE 1060.
 - b. Class I: For equipment or devices other than pressure or atmospheric vacuum breakers.

- c. Class I-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
 - 1) Housing: Reinforced[-aluminum] [or] [-fiberglass] <Insert housing> construction.
 - a) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
 - b) Drain opening for units with drain connection.
 - c) Access doors with locking devices.
 - d) Insulation inside housing.
 - e) Anchoring devices for attaching housing to concrete base.
 - 2) Electric heating cable or heater with self-limiting temperature control.

B. Weather-Resistant Enclosures:

- 1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
- 2. Description: Uninsulated enclosure designed to protect aboveground water piping, equipment, or specialties from weather and damage.
 - a. Standard: ASSE 1060.
 - b. Class III: For equipment or devices other than pressure or atmospheric vacuum breakers.
 - c. Class III-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
 - 1) Housing: Reinforced[-aluminum] [or] [-fiberglass] <Insert housing> construction.
 - a) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
 - b) Drain opening for units with drain connection.
 - c) Access doors with locking devices.
 - d) Anchoring devices for attaching housing to concrete base.

C. Expanded-Metal Enclosures:

- 1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
- 2. Description: Enclosure designed to protect aboveground water piping, equipment, or specialties from damage.
 - a. Material: ASTM F 1267, expanded metal side and top panels, of weight and with reinforcement of same metal at edges as required for rigidity.
 - b. Type: Type[I, expanded] [II, expanded and flattened].
 - c. Class: Class[1, uncoated carbon steel] [2, hot-dip, zinc-coated carbon steel] [3, corrosion-resisting steel].
 - d. Finish: Manufacturer's enamel paint.
 - e. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
 - f. Locking device.

- g. Lugs or devices for securing enclosure to base.

D. Enclosure Bases:

1. Description: [4-inch- (100-mm-)] [6-inch- (150-mm-)] minimum thickness precast concrete, of dimensions required to extend at least 6 inches (150 mm) beyond edges of enclosure housings. Include openings for piping.

2.26 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Description: Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
 - a. Standard: AWWA C502.
 - b. Pressure Rating: [150 psig (1035 kPa) minimum] [250 psig (1725 kPa)].
3. Description: Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
 - a. Standards: UL 246, FMG approved.
 - b. Pressure Rating: [150 psig (1035 kPa) minimum] [250 psig (1725 kPa)].
 - c. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
 - d. Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
 - e. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
 - f. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

B. Wet-Barrel Fire Hydrants:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Description: Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, NPS 6 (DN 150) threaded or flanged inlet, and base section with NPS 6 (DN 150) mechanical-joint inlet. Include interior coating according to AWWA C550.
 - a. Standard: AWWA C503.
 - b. Pressure Rating: 150 psig (1035 kPa) minimum.
3. Description: Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, NPS 6 (DN 150) threaded or flanged inlet, and base section with NPS 6 (DN 150) mechanical-joint inlet.
 - a. Standards: UL 246 and FMG approved.

- b. Pressure Rating: 150 psig (1035 kPa) minimum.
- c. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
- d. Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
- e. Direction of Opening: Open hydrant valves by turning operating nut to left or counterclockwise.
- f. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

2.27 FLUSHING HYDRANTS

A. Post-Type Flushing Hydrants:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
 - a. Pressure Rating: 150 psig (1035 kPa) minimum.
 - b. Outlet: One, with horizontal discharge.
 - c. Hose Thread: NPS 2-1/2 (DN 65), with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
 - d. Barrel: Cast-iron or steel pipe with breakaway feature.
 - e. Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
 - f. Security: Locking device for padlock.
 - g. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
 - h. Inlet: NPS 2 (DN 50) minimum.
 - i. Operating Wrench: One for each unit.

B. Ground-Type Flushing Hydrants:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
 - a. Pressure Rating: 150 psig (1035 kPa) minimum.
 - b. Outlet: One, with [vertical] [angle] discharge.
 - c. Hose Thread: NPS 2-1/2 (DN 65), with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
 - d. Barrel: Cast-iron or steel pipe.
 - e. Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
 - f. Inlet: NPS 2 (DN 50) minimum.
 - g. Hydrant Box: Cast iron with cover, for ground mounting.
 - h. Operating Wrench: One for each unit.

C. Post-Type Sampling Station:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
 - a. Pressure Rating: 100 psig (690 kPa) minimum.

- b. Sampling Outlet: One unthreaded nozzle with handle.
- c. Valve: Bronze body with bronze-ball or plunger closure. Include operating handle.
- d. Drain: Tubing with separate manual vacuum pump.
- e. Inlet: NPS 3/4 (DN 20) minimum.
- f. Housing: Weatherproof material with locking device. Include anchor device.
- g. Operating Wrench: One for each unit.

2.28 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connections:

- 1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
- 2. Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- (460-mm-) high brass sleeve; and round escutcheon plate.
 - a. Standard: UL 405.
 - b. Connections: Two NPS 2-1/2 (DN 65) inlets and one [NPS 4 (DN 100)] [NPS 6 (DN 150)] outlet.
 - c. Connections: [Three] [Four] NPS 2-1/2 (DN 65) inlets and one NPS 6 (DN 150) outlet.
 - d. Connections: Six NPS 2-1/2 (DN 65) inlets and one [NPS 6 (DN 150)] [NPS 8 (DN 200)] outlet.
 - e. Inlet Alignment: [Inline, horizontal] [Square].
 - f. Finish Including Sleeve: [Polished chrome-plated] [Rough chrome-plated] [Polished bronze].
 - g. Escutcheon Plate Marking: "[AUTO SPKR] [&] [STANDPIPE]."

2.29 ALARM DEVICES

- A. Alarm Devices, General: UL 753 and FMG approved, of types and sizes to mate and match piping and equipment.
- B. Water-Flow Indicators: Vane-type water-flow detector, rated for 250-psig (1725-kPa) working pressure; designed for horizontal or vertical installation; with 2 single-pole, double-throw circuit switches to provide 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 when cover is removed.
- C. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position.
- D. Pressure Switches: Single pole, double throw; designed to signal increase in pressure.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- C. Do not use flanges or unions for underground piping.
- D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- E. Underground water-service piping [NPS 3/4 to NPS 3 (DN 20 to DN 80)] <Insert pipe size range> shall be[any of] the following:
 - 1. Soft copper tube, [ASTM B 88, Type K (ASTM B 88M, Type A)] [ASTM B 88, Type L (ASTM B 88M, Type B)]; [wrought-copper, solder-joint fittings; and brazed] [copper, pressure-seal fittings; and pressure-sealed] joints.
 - 2. PE, ASTM pipe; [insert fittings for PE pipe; and clamped] [molded PE fittings; and heat-fusion] joints.
 - 3. PVC, Schedule [40 pipe; PVC, Schedule 40] [80 pipe; PVC, Schedule 80] socket fittings; and solvent-cemented joints.
 - 4. NPS 1 to NPS 3 (DN 25 to DN 80) fiberglass, AWWA RTRP, Class [150] [200] [250]; RTRF; and bonded joints.
 - 5. Fiberglass, AWWA RTRP, Class [150] [200] [250]; RTRF; and bonded joints.
- F. Underground water-service piping [NPS 4 to NPS 8 (DN 100 to DN 200)] <Insert pipe size range> shall be[any of] the following:
 - 1. Soft copper tube, [ASTM B 88, Type K (ASTM B 88M, Type A)] [ASTM B 88, Type L (ASTM B 88M, Type B)]; wrought-copper, solder-joint fittings; and brazed joints.
 - 2. Ductile-iron, [push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed] [mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical] [grooved-end pipe; ductile-iron-pipe appurtenances; and grooved] joints.
 - 3. PE, AWWA pipe; PE, AWWA fittings; and heat-fusion joints.
 - 4. PVC, Schedule [40 pipe; PVC, Schedule 40] [80 pipe; PVC, Schedule 80] socket fittings; and solvent-cemented joints.
 - 5. NPS 4 and NPS 6 (DN 100 and DN 150): NPS 6 (DN 150) PVC, AWWA Class 150 pipe; PVC, AWWA Class 150 [fabricated] [or] [molded] fittings; and gasketed joints.
 - 6. NPS 8 (DN 200): PVC, AWWA Class 200 pipe; [PVC, AWWA Class 200 fabricated] [push-on-joint, ductile-iron] [mechanical-joint, ductile-iron] fittings; and gasketed joints.
 - 7. Fiberglass, AWWA RTRP, Class [150] [200] [250]; RTRF; and bonded joints.

- G. Water Meter Box Water-Service Piping [NPS 3/4 to NPS 2 (DN 20 to DN 50)] <Insert pipe size range> shall be same as underground water-service piping.
- H. Aboveground[and Vault] Water-Service Piping [NPS 3/4 to NPS 3 (DN 20 to DN 80)] <Insert pipe size range> shall be[any of] the following:
1. Hard copper tube, [ASTM B 88, Type K (ASTM B 88M, Type A)] [ASTM B 88, Type L (ASTM B 88M, Type B)]; [wrought-copper, solder-joint fittings; and brazed] [copper, pressure-seal fittings; and pressure-sealed] joints.
 2. PVC, Schedule 80 pipe; PVC, Schedule 80 [socket fittings; and solvent-cemented] [threaded fittings; and threaded] joints.
 3. NPS 1 to NPS 2 (DN 25 to DN 50) fiberglass, AWWA RTRP, Class [150] [200] [250]; RTRF; and bonded joints.
- I. Aboveground [and vault]water-service piping [NPS 4 to NPS 8 (DN 100 to DN 200)] <Insert pipe size range> shall be[any of] the following:
1. Hard copper tube, [ASTM B 88, Type K (ASTM B 88M, Type A)] [ASTM B 88, Type L (ASTM B 88M, Type B)]; wrought-copper, solder-joint fittings; and brazed joints.
 2. Ductile-iron, grooved-end pipe; ductile-iron, grooved-end appurtenances; and grooved joints.
 3. PVC, Schedule 80 pipe; PVC, Schedule 80 [socket fittings; and solvent-cemented] [threaded fittings; and threaded] joints.
 4. Fiberglass, AWWA RTRP, Class [150] [200] [250]; RTRF; and bonded joints.
- J. Underground Fire-Service-Main Piping [NPS 4 to NPS 12 (DN 100 to DN 300)] <Insert pipe size range> shall be[any of] the following:
1. Ductile-iron, [push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed] [mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical] [grooved-end pipe; ductile-iron-pipe appurtenances; and grooved] joints.
 2. PE, Class [150] [200], fire-service pipe; molded PE fittings; and heat-fusion joints.
 3. PVC, AWWA Class 150 pipe listed for fire-protection service; PVC Class 150 fabricated or molded fittings; and gasketed joints.
 4. PVC, AWWA Class 200 pipe listed for fire-protection service; PVC Class 200 fabricated fittings; and gasketed joints.
 5. Fiberglass, AWWA, FMG-approved RTRP, Class [150] [200]; RTRF; and gasketed joints.
 6. Fiberglass, UL RTRP, Class [150] [200] [250]; RTRF; and gasketed joints.
- K. Aboveground[and Vault] Fire-Service-Main Piping [NPS 4 to NPS 12 (DN 100 to DN 300)] <Insert pipe size range> shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.
- L. Underground Combined Water-Service and Fire-Service-Main Piping [NPS 6 to NPS 12 (DN 150 to DN 300)] <Insert pipe size range> shall be[any of] the following:
1. Ductile-iron, [push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed] [mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical] [grooved-end pipe; ductile-iron-pipe appurtenances; and grooved] joints.

2. PVC, AWWA Class [150] [200] pipe listed for fire-protection service; PVC fabricated or molded fittings of same class as pipe; and gasketed joints.
 3. Fiberglass, AWWA, FMG-approved RTRP, Class [150] [200]; RTRF; and gasketed joints.
- M. Aboveground[and Vault] Combined Water Service and Fire-Service-Main Piping [NPS 6 to NPS 12 (DN 150 to DN 300)] <Insert pipe size range> shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

3.3 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.
- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast-iron, nonrising-stem, [metal] [resilient] [high-pressure, resilient]-seated gate valves with valve box.
 2. Underground Valves, NPS 4 (DN 100) and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
 3. Use the following for valves in vaults and aboveground:
 - a. Gate Valves, NPS 2 (DN 50) and Smaller: Bronze, [nonrising] [rising] stem.
 - b. Gate Valves, NPS 3 (DN 80) and Larger: [AWWA, cast iron, OS&Y rising stem, metal seated] [AWWA, cast iron, OS&Y rising stem, resilient seated] [UL/FMG, cast iron, OS&Y rising stem].
 - c. Check Valves: [AWWA C508] [UL/FMG], swing type.
 4. Pressure-Reducing Valves: Use for water-service piping in vaults and aboveground to control water pressure.
 5. Relief Valves: Use for water-service piping in vaults and aboveground.
 - a. Air-Release Valves: To release accumulated air.
 - b. Air/Vacuum Valves: To release or admit large volume of air during filling of piping.
 - c. Combination Air Valves: To release or admit air.
 6. Detector Check Valves: Use for water-service piping in vaults and aboveground to detect unauthorized use of water.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. See Section 330500 "Common Work Results for Utilities" for piping-system common requirements.

3.5 PIPING INSTALLATION

- A. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.
- B. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.
- C. Make connections larger than NPS 2 (DN 50) with tapping machine according to the following:
 - 1. Install tapping sleeve and tapping valve according to 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.
- D. Make connections NPS 2 (DN 50) and smaller with drilling machine according to the following:
 - 1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
 - 2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
 - 3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
 - 4. Install corporation valves into service-saddle assemblies.
 - 5. Install manifold for multiple taps in water main.
 - 6. Install curb valve in water-service piping with head pointing up and with service box.
- E. Comply with NFPA 24 for fire-service-main piping materials and installation.
 - 1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
 - 2. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
- F. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
 - 1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
- G. Install PE pipe according to ASTM D 2774 and ASTM F 645.
- H. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
- I. Install fiberglass AWWA pipe according to AWWA M45.
- J. Bury piping with depth of cover over top at least [30 inches (750 mm)] <Insert dimension>, with top at least [12 inches (300 mm)] <Insert dimension> below level of maximum frost penetration, and according to the following:
 - 1. Under Driveways: With at least [36 inches (910 mm)] <Insert dimension> cover over top.
 - 2. Under Railroad Tracks: With at least [48 inches (1220 mm)] <Insert dimension> cover over top.

3. In Loose Gravelly Soil and Rock: With at least [12 inches (300 mm)] <Insert dimension> additional cover.
- K. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
- L. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
 1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
- M. Sleeves are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- N. Mechanical sleeve seals are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- O. 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.
- P. See Section 211200 "Fire-Suppression Standpipes," Section 211313 "Wet-Pipe Sprinkler Systems," and Section 211316 "Dry-Pipe Sprinkler Systems" for fire-suppression-water piping inside the building.
- Q. See Section 221116 "Domestic Water Piping" for potable-water piping inside the building.

3.6 JOINT CONSTRUCTION

- A. See Section 330500 "Common Work Results for Utilities" for basic piping joint construction.
- B. Make pipe joints according to the following:
 1. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.
 2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
 3. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
 4. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
 5. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
 6. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
 7. Fiberglass Piping Bonded Joints: Use adhesive and procedure recommended by piping manufacturer.
 8. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

- a. Dielectric Fittings for [NPS 2 (DN 50)] <Insert pipe size> and Smaller: Use dielectric [nipples] [unions].
- b. Dielectric Fittings for [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)] <Insert pipe size range>: Use dielectric [flanges] [flange kits] [nipples].
- c. Dielectric Fittings for [NPS 5 (DN 125)] <Insert pipe size> and Larger: Use dielectric flange kits.

3.7 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 1. Concrete thrust blocks.
 2. Locking mechanical joints.
 3. Set-screw mechanical retainer glands.
 4. Bolted flanged joints.
 5. Heat-fused joints.
 6. Pipe clamps and tie rods.
 7. <Insert devices>.
- 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: According to AWWA C600.
 2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
 3. Bonded-Joint Fiberglass, Water-Service Piping: According to AWWA M45.
 4. Fire-Service-Main Piping: According to NFPA 24.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.8 VALVE INSTALLATION

- 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/FMG, 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/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.
- E. MSS Valves: Install as component of connected piping system.
- F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.
- G. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves.[Install full-size valved bypass.]

- H. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

3.9 DETECTOR-CHECK VALVE INSTALLATION

- A. Install in vault or aboveground.
- B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.
- C. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers.

3.10 WATER METER INSTALLATION

- A. Install water meters, piping, and specialties according to utility company's written instructions.
- B. Water Meters: Install [displacement] [turbine]-type water meters, NPS 2 (DN 50) and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.
- C. Water Meters: Install [compound] [turbine]-type water meters, NPS 3 (DN 80) and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
- D. Water Meters: Install detector-type water meters in meter vault according to AWWA M6. Include shutoff valves on water meter inlets and outlets and full-size valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

3.11 ROUGHING-IN FOR WATER METERS

- A. Rough-in piping and specialties for water meter installation according to utility company's written instructions.

3.12 VACUUM BREAKER ASSEMBLY INSTALLATION

- A. Install pressure vacuum breaker assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

3.13 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

- B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
- C. Do not install bypass piping around backflow preventers.
- D. Support NPS 2-1/2 (DN 65) and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.14 WATER METER BOX INSTALLATION

- A. Install water meter boxes in paved areas flush with surface.
- B. Install water meter boxes in grass or earth areas with top [2 inches (50 mm)] <Insert dimension> above surface.

3.15 CONCRETE VAULT INSTALLATION

- A. Install precast concrete vaults according to ASTM C 891.

3.16 PROTECTIVE ENCLOSURE INSTALLATION

- A. Install concrete base level and with top approximately [2 inches (50 mm)] <Insert measurement> above grade.
- B. Install protective enclosure over valves and equipment.
- C. Anchor protective enclosure to concrete base.

3.17 FIRE HYDRANT INSTALLATION

- A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.
- C. AWWA Fire Hydrants: Comply with AWWA M17.
- D. UL/FMG Fire Hydrants: Comply with NFPA 24.

3.18 FLUSHING HYDRANT INSTALLATION

- A. Install post-type flushing hydrants with valve below frost line and provide for drainage. Support in upright position. Include separate gate valve or curb valve and restrained joints in supply piping.

- B. Install ground-type flushing hydrants with valve below frost line and provide for drainage. Install hydrant box flush with grade. Include separate gate valve or curb valve and restrained joints in supply piping.
- C. Install sampling stations with valve below frost line and provide for drainage. Attach weather-resistant housing and support in upright position. Include separate curb valve in supply piping.

3.19 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install ball drip valves at each check valve for fire department connection to mains.
- B. Install protective pipe bollards [on two sides of] [on three sides of] <Describe arrangement> each fire department connection. Pipe bollards are specified in Section 055000 "Metal Fabrications."

3.20 ALARM DEVICE INSTALLATION

- A. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.
- B. Supervisory Switches: Supervise valves in open position.
 - 1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
 - 2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
- C. Locking and Sealing: Secure unsupervised valves as follows:
 - 1. Valves: Install chain and padlock on open OS&Y gate valve.
 - 2. Post Indicators: Install padlock on wrench on indicator post.
- D. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.
- E. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.
- F. Connect alarm devices to building fire alarm system. Wiring and fire-alarm devices are specified in Section 284621.11 "Addressable Fire-Alarm Systems" and Section 284621.13 "Conventional Fire-Alarm Systems."

3.21 CONNECTIONS

- A. See Section 330500 "Common Work Results for Utilities" for piping connections to valves and equipment.
- B. Connect water-distribution piping to [utility water main] [existing water main] <Insert piping system>. Use [tapping sleeve and tapping valve] [service clamp and corporation valve] <Insert method>.

- C. Connect water-distribution piping to interior [domestic water] [and] [fire-suppression] piping.
- D. Connect waste piping from concrete vault drains to [sanitary sewerage system. See Section 221313 "Facility Sanitary Sewers" for connection to sanitary-sewer] [storm-drainage system. See Section 334400 "Storm Utility Drainage Piping" for connection to storm-sewer] piping.
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.22 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 (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) 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.

3.23 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."
- B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Section 330500 "Common Work Results for Utilities" for identifying devices.

3.24 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 NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.

3. 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. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
 - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
 - d. 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.

END OF SECTION 221113

SECTION 22 1116
DOMESTIC WATER PIPING

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 domestic and non-potable water piping and water meters inside the building.
- B. Related Sections include the following:
 - 1. Section 23 0519 "Meters and Gages for Mechanical Piping" for thermometers, pressure gages, and fittings.
 - 2. Section 22 4100 "Plumbing Specialties" for water distribution piping specialties.
 - 3. Section 23 0553 "Identification for Mechanical" for labeling and identifying domestic water piping.
 - 4. Section 23 0523 "General-Duty Valves for Mechanical Piping" for valves in domestic water piping.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing domestic water piping systems with 150 psig, unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, couplings, and water meters.
- B. Water Disinfecting and Samples: Specified in Part 3 "Cleaning" Article.
- C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. All piping, fittings, valves and other components installed within a potable water distribution system shall comply with NSF 61 "Drinking Water System Components - Health Effects."
- C. In the State of Maryland, all piping, fittings, valves and other components installed within a potable water system intended for human consumption shall comply with NSF 61 Annex G "Drinking Water System Components – Lead Content" or NSF 372 "Drinking Water System

Components – Lead Content.” Lead content shall comply with Regulation .03 under COMAR 09.20.01 State Plumbing Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, lead-free, Types K and L, water tube, drawn temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
 - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.4 DUCTILE-IRON PIPE AND FITTINGS

- A. Restrained Mechanical-Joint, Ductile-Iron Pipe: AWWA C151/A21.10, cement lined, with restrained mechanical-joint, bell- and plain-spigot end; minimum ANSI Class 50 wall thickness.
 - 1. Pipe and Fitting Lining: AWWA C104 double-thickness cement mortar.
 - 2. Coating:
 - a. Pipe: AWWA C151 bituminous coating on outside, coating approved for potable water service on inside.
 - b. Fittings: AWWA C153 bituminous coating on outside, coating approved for potable water service on inside.
 - 3. Restrained Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile-iron standard pattern, 250 psig pressure rating or AWWA C153, ductile-iron compact pattern, 350 psig pressure rating.

- a. Glands, Gaskets, and Bolts: AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

2.5 PIPE JOINING MATERIALS

- A. Solder Filler Metals: ASTM B32, lead-free alloys.
- B. Flux: ASTM B813, water flushable.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.6 VALVES

- A. Bronze and cast-iron, general-duty valves are specified in Section 23 0523 "General-Duty Valves for Mechanical Piping."
- B. Balancing and drain valves are specified in Section 22 4100 "Plumbing Specialties."

2.7 WATER METERS

- A. Turbine-Type Water Meters: Bronze body, tested and certified to AWWA C701, 150 psig minimum working pressure rating, 30 deg. F to 130 deg. F temperature range, 1.5 percent accuracy at flow rate, with registration in gallons, and mechanical totalizer.
 1. End connections:
 - a. NPS 2 and Smaller: Threaded.
 - b. NPS 2-1/2 and Larger: Flanged.
 2. Transmitter: Metal enclosure, pulse conversion to 4-20 mA signal proportional to flow rate, factory calibrated, plus or minus 0.5 percent accuracy, plus or minus 0.1 percent of full scale repeatability, 115 VAC, maximum 10 VA.
 - a. Coordinate output with building automation system specified in Section 23 0900 "Instrumentation and Control for HVAC ."
 3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Badger Meter, Inc. Model Industrial Turbo with Recordall Electronic Transmitter.
 - b. ABB.
 - c. Hersey.
 - d. Master Meter, Inc.
 - e. Sensus.
 - f. Mueller Company.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPE AND FITTING APPLICATIONS

- 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 may be used on aboveground piping, unless otherwise indicated.
- C. Underground Domestic Potable Water Service Piping: Use the following piping materials for each size range:
 - 1. NPS 3 and Smaller: Hard copper tube, lead-free Type K; copper pressure fittings; and lead-free soldered joints with a bituminous coating on exterior of pipe and fittings.
 - 2. NPS 4 to NPS 8: AWWA C151 restrained mechanical-joint, cement lined ductile-iron pipe; mechanical-joint, ductile-iron fittings; and restrained, gasketed joints up to 5 feet outside building.
- D. Underground Non-Potable Water and Trap Priming Service Piping:
 - 1. NPS 3 and Smaller: Hard copper tube, Type K; copper pressure fittings; and soldered joints with a bituminous coating on exterior of pipe and fittings.
- E. Aboveground Domestic Potable Water Piping: Use the following piping materials for each size range:
 - 1. All Sizes: Hard copper tube, lead-free Type L; copper pressure fittings; and lead-free soldered joints.
- F. Aboveground Non-Potable-Water and Trap Priming Piping: Use the following piping materials for each size range:
 - 1. All Sizes: Hard copper tube, Type L; copper pressure fittings; and soldered joints.

3.3 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use bronze ball valves for piping NPS 2 and smaller. Use ferrous alloy butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use ferrous alloy butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
 - 4. Drain Duty: Hose-end drain valves.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures

that do not have supply stops. Use ball valves for piping NPS 2 and smaller. Use butterfly valves for piping NPS 2-1/2 and larger.

- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
 - 1. Install stop-and-waste drain valves where indicated.
- D. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Calibrated balancing valves are specified in Section 22 4100 "Plumbing Specialties."

3.4 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 considerations. Install piping, valves, etc., as indicated unless deviations to layout are approved beforehand.
- B. Basic piping installation requirements are specified in Section 23 0500 "Common Work Results for Mechanical."
- C. Install under-building-slab copper tubing according to CDA's "Copper Tube Handbook."
- D. Install sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.
- 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. Pressure gages are specified in Section 23 0519 "Meters and Gages for Mechanical Piping," and drain valves and strainers are specified in Section 22 4100 "Plumbing Specialties."
- F. Install domestic water piping level without pitch and plumb.
- G. Rough-in domestic water piping for water-meter installation according to utility company's and/or Owner's requirements.
- H. Install ductile-iron, water-service piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

3.5 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Section 23 0500 "Common Work Results for Mechanical."
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- C. Ductile-Iron Piping, Restrained Mechanical Joints: AWWA C151.

3.6 WATER METER INSTALLATION

- A. Install water meters according to AWWA M6 and utility's and/or Owner's requirements.
 - 1. Install turbine-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
 - 2. Install remote registration system according to standards of utility and of authorities having jurisdiction.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support devices are specified in Section 23 0529 "Hangers and Supports for Mechanical Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - 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: MSS Type 49, spring cushion rolls, if indicated.
 - 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.
- B. Install supports according to Section 23 0529 "Hangers and Supports for Mechanical Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 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.

3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.

- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic and/or non potable water piping to water-service piping with shutoff valve, and extend and connect to the following:
 - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 - 2. Water Heaters: Cold-water supply 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 required by plumbing code. Refer to Section 22 4000 "Plumbing Fixtures."
 - 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.

3.9 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 23 0533 "Identification for Mechanical Piping and Equipment."

3.10 FIELD QUALITY CONTROL

- A. Inspect domestic potable and non-potable and trap priming water piping as follows:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. 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:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test domestic potable and non-potable and trap priming water piping as follows:
 - 1. Fill all water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. 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.
 - 3. Leave new, altered, extended, or replaced domestic and non-potable water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. 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.

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.

3.11 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. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and plugs used 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 used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.12 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by local plumbing code or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as 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. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION 22 1116

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. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron, gravity sewer pipe and fittings.
4. Ductile-iron, pressure pipe and fittings.
5. ABS pipe and fittings.
6. PVC pipe and fittings.
7. Fiberglass pipe and fittings.
8. Concrete pipe and fittings.
9. Nonpressure-type transition couplings.
10. Pressure-type pipe couplings.
11. Expansion joints and deflection fittings.
12. Backwater valves.
13. Cleanouts.
14. Encasement for piping.
15. Manholes.
16. Concrete.

1.3 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Pipe and fittings.
2. Non-pressure and pressure couplings
3. Expansion joints and deflection fittings.
4. Backwater valves.
5. Cleanouts.

- B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.5 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.
2. Show system piping in profile. Draw profiles to horizontal scale of not less than 1 inch equals 50 feet (1:500) and to vertical scale of not less than 1 inch equals 5 feet (1:50). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

B. Product Certificates: For each type of pipe and fitting.

C. Field quality-control reports.

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 according to manufacturer's written rigging instructions.

1.7 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] [Construction Manager] [Owner] no fewer than [two] <Insert number> days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without [Architect's] [Construction Manager's] [Owner's] written permission.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, [Service class] [Service and Extra-Heavy classes] [and] [Extra-Heavy class].
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI-Trademark, Shielded Couplings:
 - 1. Description: ASTM C 1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
 - 2. <Double click here to find, evaluate, and insert list of manufacturers and products.>
- C. Heavy-Duty, Shielded Couplings:
 - 1. Description: ASTM C 1277 and ASTM C 1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
 - 2. <Double click here to find, evaluate, and insert list of manufacturers and products.>
- D. Cast-Iron, Shielded Couplings:
 - 1. Description: ASTM C 1277 with ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.
 - 2. <Double click here to find, evaluate, and insert list of manufacturers and products.>
- E. Unshielded Couplings:
 - 1. Description: ASTM C 1277 and ASTM C 1461, rigid, sleeve-type, reducing- or transition-type mechanical coupling, with integral, center pipe stop, molded from ASTM C 1440, thermoplastic elastomer (TPE) material; with corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 2. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.3 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

- A. Pipe: ASTM A 746, for push-on joints.
- B. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, for push-on joints.
- C. Compact Fittings: AWWA C153/A21.53, ductile iron, for push-on joints.
- D. Gaskets: AWWA C111/A21.11, rubber.

2.4 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS

- A. Push-on-Joint Piping:
 - 1. Pipe: AWWA C151/A21.51.
 - 2. Standard Fittings: AWWA C110/A21.10, ductile or gray iron.
 - 3. Compact Fittings: AWWA C153/A21.53.

4. Gaskets: AWWA C111/A21.11, rubber, of shape matching pipe and fittings.

B. Mechanical-Joint Piping:

1. Pipe: AWWA C151/A21.51, with bolt holes in bell.
2. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, with bolt holes in bell.
3. Compact Fittings: AWWA C153/A21.53, with bolt holes in bells.
4. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
5. Gaskets: AWWA C111/A21.11, rubber, of shape matching pipe, fittings, and glands.

2.5 ABS PIPE AND FITTINGS

A. ABS Sewer Pipe and Fittings: ASTM D 2661, with bell-and-spigot ends for gasketed joints.

1. NPS 3 to NPS 6 (DN 80 to DN 150): SDR 35.
2. NPS 8 to NPS 12 (DN 200 to DN 300): SDR 42.

B. Gaskets: ASTM F 477, elastomeric seals.

2.6 PVC PIPE AND FITTINGS

A. PVC Cellular-Core Sewer Piping:

1. Pipe: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
2. Fittings: ASTM D 3034, [SDR 35] <Insert SDR>, PVC socket-type fittings.

B. PVC Corrugated Sewer Piping:

1. Pipe: ASTM F 949, PVC corrugated pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
3. Gaskets: ASTM F 477, elastomeric seals.

C. PVC Profile Sewer Piping:

1. Pipe: ASTM F 794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

D. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D 3034, [SDR 35] <Insert SDR>, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

E. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F 679, [T-1] [T-2] wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

F. PVC Pressure Piping:

1. Pipe: AWWA C900, [Class 100] [Class 150] [and] [Class 200] PVC pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: AWWA C900, [Class 100] [Class 150] [and] [Class 200] PVC pipe with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

G. PVC Water-Service Piping:

1. Pipe: ASTM D 1785, [Schedule 40] [and] [Schedule 80] PVC, with plain ends for solvent-cemented joints.
2. Fittings: [ASTM D 2466, Schedule 40] [and] [ASTM D 2467, Schedule 80] PVC, socket type.

2.7 FIBERGLASS PIPE AND FITTINGS

A. Fiberglass Sewer Pipe: ASTM D 3262, RTRP, for gasketed joints fabricated with [Type 2, polyester] [or] [Type 4, epoxy] resin.

1. Liner: [Reinforced thermoset] [Nonreinforced thermoset] [Thermoplastic] [No liner].
2. Grade: [Reinforced, surface layer matching pipe resin] [Nonreinforced, surface layer matching pipe resin] [No surface layer] <Insert grade>.
3. Stiffness: [9 psig (62 kPa)] [18 psig (124 kPa)] [36 psig (248 kPa)] [72 psig (496 kPa)].

B. Fiberglass Nonpressure Fittings: ASTM D 3840, RTRF, for gasketed joints.

1. Laminating Resin: [Type 1, polyester] [or] [Type 2, epoxy] resin.
2. Reinforcement: Grade with finish compatible with resin.

C. Gaskets: ASTM F 477, elastomeric seals.

2.8 CONCRETE PIPE AND FITTINGS

A. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C 14 (ASTM C 14M), [Class 1] [Class 2] [Class 3], with [bell-and-spigot] [or] [tongue-and-groove] ends for gasketed joints with ASTM C 443 (ASTM C 443M), rubber gaskets.

B. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M).

1. [Bell-and-spigot] [or] [tongue-and-groove] ends for gasketed joints, with ASTM C 443 (ASTM C 443M), rubber gaskets.
2. Class II, [Wall A] [Wall B] [Wall C].
3. Class III, [Wall A] [Wall B] [Wall C].
4. Class IV, [Wall A] [Wall B] [Wall C].
5. Class V, [Wall A] [Wall B].

2.9 NONPRESSURE-TYPE TRANSITION COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 2. For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
 3. For Fiberglass Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 4. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 5. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Unshielded, Flexible Couplings:
1. Description: Elastomeric sleeve with[stainless-steel shear ring and] corrosion-resistant-metal tension band and tightening mechanism on each end.
 2. <Double click here to find, evaluate, and insert list of manufacturers and products.>
- D. Shielded, Flexible Couplings:
1. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 2. <Double click here to find, evaluate, and insert list of manufacturers and products.>
- E. Ring-Type, Flexible Couplings:
1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
 2. <Double click here to find, evaluate, and insert list of manufacturers and products.>
- F. Nonpressure-Type, Rigid Couplings:
1. Description: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling; molded from ASTM C 1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.
 2. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.10 PRESSURE-TYPE PIPE COUPLINGS

- A. <Double click here to find, evaluate, and insert list of manufacturers and products.>
- B. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.
- C. Metal, bolted, sleeve-type, reducing or transition coupling; for joining underground pressure piping. Include [150-psig (1035-kPa)] [200-psig (1380-kPa)] <Insert value> minimum pressure rating and ends of same sizes as piping to be joined.

- D. Center-Sleeve Material: [Manufacturer's standard] [Carbon steel] [Stainless steel] [Ductile iron] [Malleable iron].
- E. Gasket Material: Natural or synthetic rubber.
- F. Metal Component Finish: Corrosion-resistant coating or material.

2.11 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron, Flexible Expansion Joints:

- 1. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig (1725-kPa) minimum working pressure and for offset and expansion indicated.
- 2. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Ductile-Iron Expansion Joints:

- 1. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include rating for 250-psig (1725-kPa) minimum working pressure and for expansion indicated.
- 2. <Double click here to find, evaluate, and insert list of manufacturers and products.>

C. Ductile-Iron Deflection Fittings:

- 1. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include rating for 250-psig (1725-kPa) minimum working pressure and for up to 15 degrees of deflection.
- 2. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.12 BACKWATER VALVES

A. Cast-Iron Backwater Valves:

- 1. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
- 2. <Double click here to find, evaluate, and insert list of manufacturers and products.>
- 3. Horizontal type; with swing check valve and hub-and-spigot ends.
- 4. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
- 5. Terminal type; with bronze seat, swing check valve, and hub inlet.

B. PVC Backwater Valves:

- 1. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.
- 2. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.13 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. <Double click here to find, evaluate, and insert list of manufacturers and products.>
3. Top-Loading Classification(s): [Light Duty] [Medium Duty] [Heavy Duty] [and] [Extra-Heavy Duty].
4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.
2. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.14 ENCASUREMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.
- B. Material: [Linear low-density polyethylene film of 0.008-inch (0.20-mm)] [or] [high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm)] minimum thickness.
- C. Form: [Sheet] [or] [tube].
- D. Color: [Black] [or] [natural] <Insert color>.

2.15 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches (1200 mm) 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 (150-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 4-inch (100-mm) 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 C 990 (ASTM C 990M), bitumen or butyl rubber.

8. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
9. Steps: [Individual FRP steps or FRP ladder] [Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP] [ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP] <Insert material>; 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 (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than [60 inches (1500 mm)] <Insert dimension>.
10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) 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. Designed Precast Concrete Manholes:

1. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44 in AASHTO HL), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
2. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
3. Joint Sealant: ASTM C 990 (ASTM 990M), bitumen or butyl rubber.
4. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
5. Steps: [Individual FRP steps or FRP ladder] [Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP] [ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP] <Insert material>; 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 (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than [60 inches (1500 mm)] <Insert dimension>.
6. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
7. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) 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.

C. Fiberglass Manholes:

1. Description: ASTM D 3753.
2. <Double click here to find, evaluate, and insert list of manufacturers and products.>
3. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
4. Ballast: Increase thickness of concrete base as required to prevent flotation.

5. Base Section: Concrete, 6-inch (150-mm) minimum thickness.
6. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
7. Steps: Individual FRP steps or FRP ladder, 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 (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than [60 inches (1500 mm)] <Insert dimension>.
8. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
9. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) 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.

D. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser, with 4-inch- (100-mm-) minimum-width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: [ASTM A 536, Grade 60-40-18 ductile] [ASTM A 48/A 48M, Class 35 gray] iron unless otherwise indicated.

E. 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. <Double click here to find, evaluate, and insert list of manufacturers and products.>
3. Type: [Solid] [Drainage with vent holes] [Valve].

2.16 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350 (ACI 350M), and the following:

1. Cement: ASTM C 150/C 150M, Type II.
2. Fine Aggregate: ASTM C 33/C 33M, sand.
3. Coarse Aggregate: ASTM C 33/C 33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 1064/A 1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420-MPa) deformed steel.

- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) 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] [2] percent through manhole.
 - 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: [4] [8] percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.
 - 1. Reinforcing Fabric: ASTM A1064/A 1064M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420-MPa) 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. 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 according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of [1] [2] <Insert number> percent unless otherwise indicated.
 2. Install piping [NPS 6 (DN 150)] <Insert pipe size> 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 (915-mm)] [48-inch (1220-mm)] [60-inch (1520-mm)] [72-inch (1830-mm)] <Insert dimension> minimum cover.
 4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 5. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 6. Install ductile-iron, gravity sewer piping according to ASTM A 746.
 7. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
 8. Install PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 1668.
 9. Install PVC corrugated sewer piping according to ASTM D 2321 and ASTM F 1668.
 10. Install PVC profile sewer piping according to ASTM D 2321 and ASTM F 1668.
 11. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
 12. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
 13. Install fiberglass sewer piping according to ASTM D 3839 and ASTM F 1668.
 14. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
 15. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
- G. Install force-main, pressure piping according to the following:
1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 2. Install piping with [36-inch (915-mm)] [48-inch (1220-mm)] [60-inch (1520-mm)] [72-inch (1830-mm)] <Insert dimension> minimum cover.
 3. Install ductile-iron pressure piping according to AWWA C600 or AWWA M41.
 4. Install ductile-iron special fittings according to AWWA C600.
 5. Install PVC pressure piping according to AWWA M23 or to ASTM D 2774 and ASTM F 1668.
 6. Install PVC water-service piping according to ASTM D 2774 and ASTM F 1668.
- H. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105/A21.5:
1. Hub-and-spigot, cast-iron soil pipe.
 2. Hubless cast-iron soil pipe and fittings.
 3. Ductile-iron pipe and fittings.
 4. Expansion joints and deflection fittings.
- I. 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 hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 2. 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.
 3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
 4. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
 5. Join ABS sewer piping according to ASTM D 2321 for elastomeric-seal joints.
 6. Join PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
 7. Join PVC corrugated sewer piping according to ASTM D 2321.
 8. Join PVC profile sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
 9. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
 10. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
 11. Join fiberglass sewer piping according to ASTM D 4161 for elastomeric-seal joints.
 12. Join nonreinforced-concrete sewer piping according to ASTM C 14 (ASTM C 14M) and ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
 13. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
 14. Join dissimilar pipe materials with nonpressure-type, flexible[or rigid] couplings.
- B. Join force-main, pressure piping according to the following:
1. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.
 2. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
 3. Join PVC pressure piping according to AWWA M23 for gasketed joints.
 4. Join PVC water-service piping according to ASTM D 2855.
 5. Join dissimilar pipe materials with pressure-type couplings.
- C. 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 flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. [Unshielded] [Shielded] flexible[or rigid]couplings for pipes of same or slightly different OD.
 - b. Unshielded, increaser/reducer-pattern, flexible[or rigid]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 pipe couplings for force-main joints.

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 C 891.
- C. Install FRP manholes according to manufacturer's written instructions.
- D. Form continuous concrete channels and benches between inlets and outlet.
- E. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops [3 inches (76 mm)] <Insert dimension> above finished surface elsewhere unless otherwise indicated.
- F. 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 BACKWATER VALVE INSTALLATION

- A. Install horizontal-type backwater valves in piping manholes or pits.
- B. Install combination horizontal and manual gate-type valves in piping and in manholes.
- C. Install terminal-type backwater valves on end of piping and in manholes. Secure units to sidewalls.

3.7 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 Light-Duty, top-loading classification cleanouts in [earth or unpaved foot-traffic] <Insert other> areas.
 2. Use Medium-Duty, top-loading classification cleanouts in [paved foot-traffic] <Insert other> areas.
 3. Use Heavy-Duty, top-loading classification cleanouts in [vehicle-traffic service] <Insert other> areas.
 4. Use Extra-Heavy-Duty, top-loading classification cleanouts in [roads] <Insert area>.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, [18 by 18 by 12 inches (450 by 450 by 300 mm)] <Insert dimensions> deep. Set with tops [1 inch (25 mm)] <Insert dimension> above surrounding grade.

- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.8 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."
- B. Connect force-main piping to building's sanitary force mains specified in Section 221316 "Sanitary Waste and Vent 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 (150-mm) overlap with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
 - 3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches (76 mm) 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 (150 mm) of concrete for minimum length of 12 inches (300 mm) 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 (20.7 MPa) 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.
- D. Connect to [grease] [oil] [and] [sand] interceptors specified in Section 221323 "Sanitary Waste Interceptors."

3.9 CLOSING ABANDONED SANITARY SEWER SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least [8-inch- (203-mm-)] <Insert dimension> thick, brick masonry bulkheads.
 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
1. Remove manhole and close open ends of remaining piping.
 2. Remove top of manhole down to at least [36 inches (915 mm)] <Insert dimension> below final grade. Fill to within [12 inches (300 mm)] <Insert dimension> of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
- C. Backfill to grade according to Section 312000 "Earth Moving."

3.10 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.

3.11 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) 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 (3-m) 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 F 1417.
 - b. Test concrete gravity sewer piping according to ASTM C 1628.
 7. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than [150 psig (1035 kPa)] <Insert value>.
 - a. Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
 - b. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
 8. Manholes: Perform hydraulic test according to ASTM C 969 (ASTM C 969M).
- 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 dirt and superfluous material from interior of piping.[Flush with potable water.]

END OF SECTION 221313

SECTION 22 1316

SANITARY WASTE AND VENT 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. This Section includes the following soil and waste, sanitary drainage and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.
- B. Related Sections include the following:
 - 1. Section 22 4100 "Plumbing Specialties" for soil, waste, and vent piping systems specialties.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE

- A. All cast iron soil pipe and fittings are to be produced by a single manufacturer and shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI).
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber. Gaskets shall be provided by the same manufacturer as for cast iron pipe.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Shielded Couplings: ASTM C 1277 assembly of metal housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Heavy-Duty, Shielded, Stainless-Steel Couplings: Coupling standard ASTM C-1540, with stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve with integral, center pipe stop.
 - a. Manufacturers:
 - 1) Anaco-Husky; Model SD 4000.
 - 2) Clamp-All Corp.

2.5 SPECIALTY PIPE FITTINGS

- A. Transition Coupling:
 - 1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - 2. Shielded, Non-pressure Transition Couplings:
 - a. Standards: ASTM C 1460 and 564.
 - 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.
- B. Dielectric Fittings:

1. Dielectric Fittings:
 - a. Description:
 - 1) Standard: ASTM F-492-77.
 - 2) Electroplated steel nipple.
 - 3) Pressure Rating: 300 psig at 225 deg F.
 - 4) End Connections: Male threaded.
 - 5) Lining: Inert and noncorrosive, thermoplastic.

2.6 NO-HUB CAST IRON PIPING RESTRAINTS

A. No-hub Cast Iron Soil Pipe Fitting Restraints:

1. Description: CISPI designation 301-12 large diameter no-hub cast iron fittings, over 4" in size, with supplemental support to minimize the risk of joint separation under high thrust conditions. Auxiliary restraint products used shall be manufactured assemblies with thrust pressure rating adequate for the specific installation. Field devised methods and materials are not permitted.

B. Manufacturers:

1. Holdrite series 117
2. Grinnell
3. Anvil

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Aboveground, soil, waste, and vent piping all sizes 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 with the following:
 - a. Couplings: Heavy-duty, type 304, stainless steel.

B. Underground, soil, waste, and vent piping all sizes shall be the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.

3.2 PIPING INSTALLATION

A. Refer to Section 23 0500 "Common Work Results for Mechanical for basic piping installation.

B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

- C. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Refer to Section 23 0500 "Common Work Results for Mechanical" for wall penetration systems.
- D. 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."
- E. No-hub pipe and fitting coupling joints over 4 inches in size shall receive auxiliary support by means of appropriate bracing materials, per all US soil pipe and fitting manufacturers' installation instructions and per CISPI Cast iron Soil Pipe and Fittings Handbook. Auxiliary restraint products used shall be manufactured assemblies with thrust pressure rating adequate for the specific installation and shall be installed onto horizontal joints over 4 inches diameter in size. Field devised methods and materials shall not be used to accomplish this application solution.
- F. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. 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. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- G. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- H. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 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 Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- I. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- J. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

- A. Refer to Section 23 0500 "Common Work Results for Mechanical for basic piping joint construction.
- B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
 - 2. Hubless Joints: Make with rubber gasket and sleeve or clamp.

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: Shielded, nonpressure 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. Refer to Section 23 0523 "General-Duty Valves for Mechanical Piping for general-duty valves.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Refer to Section 23 0529 "Hangers and Supports for Mechanical Piping and Equipment for pipe hanger and support devices. Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - 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.
- B. Install supports according to Section 23 0529 "Hangers and Supports for Mechanical Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. 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: 60 inches with 3/4-inch rod.
 - 5. NPS 8 to 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.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. In compliance with all US soil pipe and fitting manufacturers' installation instructions and per CISPI Designation 310-11, CISPI Designation 301-09 and the CISPI Cast Iron Soil Pipe

Handbook, regarding auxiliary support for no-hub cast iron pipe and fitting joints over 4 inches in size and for joints subjected to excessive thrust forces, use manufactured assemblies with appropriate thrust pressure ratings, rather than field assembled miscellaneous materials.

- H. Support piping and tubing not listed above according to MSS SP-69 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 location as indicated on the drawings. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Sections for all plumbing fixtures.
 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 drainage and vent piping in sizes indicated, but not smaller than required by plumbing code. Refer to Section 22 4100 "Plumbing Specialties."
 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.8 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 drainage 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 drainage 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 drainage and vent piping, except outside leaders, on completion of roughing-in. 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 to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures and drains have been set and traps filled with water, test connections and prove they are gastight and watertight. 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. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. 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.

3.9 CLEANING

- 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.

END OF SECTION 22 1316

SECTION 22 1413
STORM DRAINAGE 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. This Section includes storm-drainage piping inside the building and to locations indicated.
- B. Related Sections include the following:
 - 1. Section 22 4100 "Plumbing Specialties" for storm drainage piping system specialties.
 - 2. Section 22 1429 "Sump Pumps."

1.3 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.
 - 2. Storm Water Force Mains: 50 PSIG.

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE

- A. All cast iron soil pipe and fittings are to be provided by a single manufacturer and shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI).
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to project selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber. Gaskets shall be provided by the same manufacturer as for cast iron pipe

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Shielded Couplings: ASTM C 1277 assembly of metal housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Heavy-Duty, Shielded, Stainless-Steel Couplings: Coupling standard ASTM C-1540, with stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve with integral center pipe stop.

- a. Manufacturers:

- 1) Anaco-Husky; Model SD 4000.
- 2) Clamp-All Corp.

2.5 COPPER TUBING AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- B. Hard Copper Tube: ASTM B 88, Types L and K, water tube, drawn temper.
 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end.
 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.]

2.6 SPECIALTY PIPE FITTINGS

- A. Transition Coupling:

1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
2. Shielded, Non-pressure Transition Couplings:
 - a. Standards: ASTM C 1460 and 564.
 - 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.

B. Dielectric Fittings:

1. Dielectric Fittings:
 - a. Description:
 - 1) Standard: ASTM F-492-77.
 - 2) Electroplated steel nipple.
 - 3) Pressure Rating: 300 psig at 225 deg F.
 - 4) End Connections: Male threaded.
 - 5) Lining: Inert and noncorrosive, thermoplastic.

2.7 NO-HUB CAST IRON PIPING RESTRAINTS

A. No-hub Cast Iron Soil Pipe Fitting Restraints:

1. Description: CISPI designation 301-12 large diameter no-hub cast iron fittings, over 4" in size, with supplemental support to minimize the risk of joint separation under high thrust conditions. Auxiliary restraint products used shall be manufactured assemblies with thrust pressure rating adequate for the specific installation. Field devised methods and materials are not permitted.

B. Manufacturers:

1. Holdrite series 117
2. Grinnell
3. Anvil

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Aboveground storm drainage piping. All sizes shall be any of the following:

1. Service class, cast-iron soil piping and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings with the following:
 - a. Couplings: Heavy-duty, Type 304, stainless steel.

B. Underground storm, drainage piping. All sizes shall be the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
 - C. Aboveground storm drainage force mains. All sizes shall be the following:
 1. Hard copper tube, Type L; copper drainage fittings; and soldered joints.
 - D. Underground storm drainage force mains. All sizes shall be the following:
 1. Hard copper tube, Type K; copper drainage fittings; and soldered joints with bituminous coating.
- 3.2 PIPING INSTALLATION
- A. Refer to Section 23 0500 "Common Work Results for Mechanical" for basic piping installation.
 - B. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers.
 - C. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
 - D. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Refer to Section 23 0500 "Common Work Results for Mechanical" for wall penetration systems.
 - E. 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."
 - F. No-hub pipe and fitting coupling joints over 4 inches in size shall receive auxiliary support by means of appropriate bracing materials, per all US soil pipe and fitting manufacturers' installation instructions and per CISPI Designation 310-11, CISPI Designation 301-09 and the CISPI Cast Iron Soil Pipe and Fittings Handbook. Auxiliary restraint products used shall be manufactured assemblies with thrust pressure rating adequate for the specific installation and shall be installed on to horizontal joints over 4 inches diameter in size. Field devise methods and materials shall not be used to accomplish this application solution.
 - G. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
 - H. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
 - I. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
 - J. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
 1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.

2. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow.

K. Install force mains at elevations indicated.

L. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

M. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

A. Refer to Section 23 0500 "Common Work Results for Mechanical" for basic piping joint construction.

B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

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: Shielded, nonpressure 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.

3.5 VALVE INSTALLATION

A. Refer to Section 23 0523 "General-Duty Valves for Mechanical Piping" for general-duty valves.

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.

1. Use gate or full-port ball valve for piping NPS 2 and smaller.
2. Use gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, downstream from shutoff valve, on each sump pump discharge.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Refer to Section 23 0529 "Hangers and Supports for Mechanical Piping and Equipment" for pipe hanger and support devices. Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - 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.
- B. Install supports according to Section 23 0529 "Hangers and Supports for Mechanical Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. 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. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. In compliance with all US soil pipe and fitting manufacturers' installation instructions and per CISPI Designation 310-11, CISPI Designation 301-09 and the CISPI Cast Iron Soil Pipe Handbook, regarding auxiliary support for no-hub cast iron pipe and fitting joints over 4 inches in size and for joints subjected to excessive thrust forces, use manufactured assemblies with appropriate thrust pressure ratings, rather than field assembled miscellaneous materials.
- H. 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.
- I. Install supports for vertical copper tubing every 10 feet.
- J. Support piping and tubing not listed above according to MSS SP-69 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 location as indicated on the drawings**. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
- D. Connect force-main piping to the following:
 - 1. Sump Pumps: To sump pump discharge.

3.8 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. 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 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: Test storm drainage piping, except outside leaders, on completion of roughing-in. 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 to 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.
- 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. 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.

3.9 CLEANING

- 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.

END OF SECTION 22 1413

SECTION 22 1429

SUMP PUMPS

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. This Section includes the following sump pumps and accessories for storm drainage piping systems in buildings:
 - 1. Submersible elevator pit sump pump units.
- B. Related Sections include the following:
 - 1. Section 22 1413 "Storm Drainage Piping" for storm water system piping.
 - 2. Section 03 3000 "Cast-In-Place Concrete."
 - 3. Section 23 0900 "Instrumentation and Control for HVAC."
 - 4. Commissioning of equipment or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Commissioning Authority. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure.
 - a. Refer to Section 01 7700 "Closeout Procedures" for substantial completion details.
 - b. Refer to Section 01 9113 "General Commissioning Requirements," Section 22 0800 "Commissioning of Plumbing Systems," Section 23 0800 "Commissioning of Mechanical Systems," and Section 26 0800 "Electrical System Commissioning" for detailed commissioning requirements.
 - c. Refer to Section 01 7820 "Operation and Maintenance Data" for operations and maintenance data requirements.

1.3 SUBMITTALS

- A. Product Data: For each type and size of sump pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For each sump pump to include in emergency, operation, and maintenance manuals.
- D. Comply with Section 01 3300 "Submittal Procedures"

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of sump pumps and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- B. 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.
- C. 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 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 ELEVATOR PIT SUBMERSIBLE SUMP PUMP

- A. Submersible, Simplex, Fixed Position, Double Seal Sump Pumps (P-ELEV-1):
 - 1. Manufacturer:
 - a. Stancor, Inc., Model SE-50 oil-minder system with multi-pin connector.
 - 2. Provide submersible pump with discharge connection size as indicated on plans.
 - a. Pump shall be factory-assembled and tested sump pump unit.
 - b. Submersible, single stage, close-coupled centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
 - c. Pump Casing: Cast iron.
 - d. Impeller: Cast iron, statically and dynamically balanced, non-clog open, or semi-open design for solids handling and keyed and secured to shaft.
 - e. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease lubricated ball bearings and double-mechanical seals.
 - f. Motor: Air filled, hermetically sealed, capacitor-start type, with built-in overload protection.

3. Multi-Pin Connector:
 - a. Pump and control cables factory wired into a wall mounted NEMA 4X junction box. Between the junction box and main oil-minder control panel shall be a multi-pin quick connect cable. This single cord, 8-pin system allows the electrical cable between the junction box and control panel to be run through conduit (minimum 2-1/2 inch diameter) interconnected up to 250 feet long, using a single "push and turn" motion. No field wiring shall be required.
4. Control panel shall be solid state with NEMA 4X rating and shall include:
 - a. Built-in audible and visual alarm when pump does not run due to oil in the pit or high liquid or high amperage condition.
 - b. Silencing button for audible alarm.
 - c. Two contacts for a remote alarm location (one each for oil and high water or amperage alert).
 - d. Junction box provided with multi-pin connector and cords in lengths as required, 25 feet standard, optional 25-foot increments.
5. Self-cleaning, hermetically sealed stainless steel probe.
6. Float switches for pump activation and high water alert.
7. Pump Discharge Piping:
 - a. Field fabricated, copper water tube, type L, pressure type fittings, soldered joining method.
8. Provide shut-off and check valve in pumped discharge piping.
9. Third Party Certification.

2.3 PUMP BASINS

- A. Description: Basin furnished under Section 03 3000 "Cast-In-Place Concrete."
 1. Basin: Fabricate watertight, with sidewall openings for pipe connections.
 - a. Reinforcement: Mounting plates for pumps, fittings, and accessories.
 2. Cover: Fabricate water and odor tight with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
 - a. Material: Cast iron or steel with bituminous coating.
 - b. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.
 - c. Coordinate cover size with basin construction size.

2.4 BUILDING AUTOMATION SYSTEM INTERFACE

- A. Building Automation System Interface:

1. Provide auxiliary contacts for interface to building automation system. Building automation systems are specified in Section 23 0900 "Instrumentation and Control for HVAC." Include the following:
 - a. On-off status of each pump.
 - b. Alarm status.
2. Factory-installed hardware and software to allow the BAS to monitor, control, display and record data for use in preparing reports for all available monitoring and control points via BacNet interface. Refer to Section 23 0900 "Instrumentation and Control for HVAC."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.2 INSTALLATION

- A. Excavating, trenching, and backfilling are specified in Section 31 2000 "Earth Moving."
- B. Install pumps according to applicable requirements in HI 1.4.
- C. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.
- D. Set submersible pumps in basin floors. Make direct connections to storm drainage piping.
- E. Install pump and connect to drainage piping. Set basin cover and fasten to basin top flange. Install cover so top surface is flush with finished floor. Coordinate with basin construction.
- F. Support piping so weight of piping is not supported by pumps.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in Section 23 0500 "Common Work Results for Mechanical." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to pumps to allow service and maintenance.
- C. Connect storm water piping to pumps. Install discharge piping equal to or greater than size of pump discharge piping. Refer to Section 22 1413 "Storm Water Drainage Piping."
 1. Install check and shutoff valves on discharge piping from each pump. Install unions on pumps having threaded pipe connections. Install valves same size as connected piping. Refer to Section 23 0523 "General-Duty Valves for Mechanical Piping" for general-duty valves for storm drainage piping.
- D. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."

- E. Connect wiring according to Section 26 0519 "Low Voltage Electrical Power Conductors and Cables."

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify bearing lubrication.
 - 3. Disconnect couplings and check motors for proper direction of rotation.
 - 4. Verify that each pump is free to rotate by hand. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - 5. Verify that pump controls are correct for required application.
- B. Start pumps without exceeding safe motor power:
 - 1. Start motors.
 - 2. Open discharge valves slowly.
 - 3. Check general mechanical operation of pumps and motors.
- C. Test and adjust controls and safeties.
- D. Remove and replace damaged and malfunctioning components.
 - 1. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.
 - 2. Set field-adjustable switches and circuit-breaker trip ranges as indicated, or if not indicated, for normal operation.
- E. 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 outside normal occupancy hours for this purpose.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps. Refer to Section 01 7900 "Demonstration and Training."

3.6 COMMISSIONING

- A. Provide support for commissioning activities and functional performance testing as outlined in Section 01 9113 "Commissioning Plan."
- B. Perform pre-functional performance testing and submit report to Commissioning Agent and Owner's Commissioning Representative.

END OF SECTION 22 1429

SECTION 22 3300

ELECTRIC, 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. Commercial, electric, storage, domestic-water heaters.
2. Domestic-water heater accessories.
3. Thermostatic mixing valves
4. Recirculating pumps.

B. Related Sections include the following:

1. Commissioning of equipment or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Commissioning Authority. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure.
 - a. Refer to Division 01 for substantial completion details.
 - b. Refer to Division 01 Section 01 9113 "General Commissioning Requirements" and "Functional Performance Testing Procedures," Division 22 Section 22 0800 "Plumbing System Commissioning," Division 23 Section 23 0800 "HVAC System Commissioning" and "Building Automation System Commissioning," and Division 26 Section 26 0800 "Electrical System Commissioning" for detailed commissioning requirements.
 - c. Refer to Division 01 for operations and maintenance data requirements.
2. Section 22 1116 "Domestic Water Piping" for water piping.
3. Section 22 4100 "Plumbing Specialties" for water distribution piping specialties.
4. Section 23 0523 "General Duty Valves for Mechanical Piping" for ball valves and check valves
5. Section 23 0519 "Meters and Gages for Mechanical Piping" for thermometers and pressure gages.
6. Section 23 0900 "Instrumentation and Control for HVAC" for plumbing equipment connections to building automation system.
7. Section 23 0593 "Testing, Adjusting, and Balancing for HVAC" for balancing required for domestic hot water recirculation systems.

1.3 SUBMITTALS

- A. Product Certificates: For each type of commercial, electric, domestic-water heater, from manufacturer.

- B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Warranty: Sample of special warranty.
- F. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, 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. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- C. ASME Compliance: 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.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.5 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, 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. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: Three years.
 - b. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Electric, Storage, Domestic-Water Heaters:

1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
 - a. Cemline Corporation.
 - b. AO Smith
 - c. Lochinvar Corporation.
 - d. PVI Industries, LLC.
 - e. Hubble
 - f. State
2. Standard: UL 1453.
3. Storage-Tank Construction: ASME-code, steel, vertical arrangement.
 - a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - 1) Threaded ends according to ASME B1.20.1.
 - b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 Annex G / NSF-372 barrier materials for potable-water tank linings, including extending lining material into tappings.
4. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - c. Insulation: Comply with ASHRAE/IESNA 90.1.
 - d. Jacket: Steel with enameled finish.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type
 - f. Temperature Control: Adjustable thermostat.
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL Inc.
 - b. Wessels
 - c. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.

- d. State Industries.
 - e. Taco, Inc.
 - f. Watts Regulator Co..
2. Description: Steel, ASME pressure-rated tank (with stamp) 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 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. Thermostatic Water Mixing Valves (HWMV-1)
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lawler Manufacturing Company, Inc., series 800.
 - b. Leonard Valve Company.
 - c. Acorn
 - d. Symmons Industries, Inc.
 - e. Powers.
 - f. Symmons
 2. General: ASSE 1017, manually adjustable, thermostatic water mixing valve with bronze body, check stop and union on hot- and cold-water-supply inlets, removable stainless steel strainers on inlets, and protection against hot or cold water supply failure and thermostat failure. Provide one of the following types:
 - a. Type: Bimetal thermostat, operation and pressure rating 125 psig minimum.
 - b. Type: Liquid-filled motor, operation and pressure rating 100 psig minimum.
 3. Manifold Recirculation System: Pre-piped manifold system with mixing valve, recirculation pump, interconnecting piping, ball valves, thermometers, check valves, circuit setting balancing valve, and mounting strut.
 - a. Mixing Valve: Hi-low flow type that satisfies scheduled maximum and minimum flow rates or manifold parallel type consisting of one large-flow, thermostatic water mixing valve with flow-control valve, pressure regulator, inlet and outlet pressure gages, and one small-flow, thermostatic water mixing valve with flow-control valve.
 - b. Hot Water Recirculating Pump: Refer to specification below.
 - c. Mounting Strut: Metal, with epoxy coating, sized to house and support components.
 - d. Piping and Fittings: Refer to Division 22 Section 22 1116 "Domestic Water Piping."
 - e. Ball Valves and Check Valves: Refer to Division 23 Section 23 0523 "General-Duty Valves for Mechanical Piping."

- f. Thermometers: Refer to Division 23 Section 23 0519 "Meters and Gages for Mechanical Piping."
- g. Calibrated Balancing Valve: Refer to Division 22 Section 22 4100 "Plumbing Specialties."
- h. Refer to drawings for required piping arrangements and appurtenances.

C. Hot Water Recirculating Pumps (P-DHWR-1)

- 1. Manufacturers: subject to compliance with requirements, provide products by one of the following:
 - a. In-Line Circulators:
 - 1) Taco, Inc. 00 Series
 - 2) Amtrol, Inc.
 - 3) Grundfos.
 - 4) ITT Fluid Technology Corp.; ITT Bell & Gossett Div.
- 2. Description: In-line circulator, rated for 150 psig maximum working pressure and maximum continuous water temperature of 225 deg. F, approved for use in potable water systems.
 - a. Construction: Radially split, all-bronze casing.
 - b. Impeller: Noryl or polypropylene.
 - c. Seal: Mechanical.
 - d. Shaft and Sleeve: Steel shaft, with oil-lubricated copper sleeve.
 - e. Pump Bearings: Double-Sintered Carbon
 - f. Shaft Coupling: Ceramic.
 - g. Motor: Single speed, with oil-lubricated bearings, unless otherwise indicated; and resiliently mounted to pump casing.
- 3. Motors: Comply with requirements in Division 23 Section 23 0513 "Common Motor Requirements for Mechanical Equipment" with built-in thermal-overload protection appropriate for motor size and duty.
- 4. End Connections for NPS 2 and Smaller: Threaded. Pumps available only with flanged ends may be furnished with threaded companion flanges.
- 5. Pumps to be installed with master mixing valve assemblies for domestic hot water systems.

D. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

E. Heat-Trap Fittings: ASHRAE 90.2.

F. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 4000 "Quality Requirements" for retesting and reinspecting requirements and Section 01 7300 "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 03 3000 "Cast-in-Place Concrete."
- B. Install electric, domestic-water heaters level and plumb, according to 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. Comply with requirements for shutoff valves specified in Section 23 0523 "General Duty Valves for Mechanical Piping"
- C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-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.
- D. 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 electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 4100 "Plumbing Specialties."
- E. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 23 0519 "Meters and Gages for Mechanical Piping."
- F. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- G. Fill electric, domestic-water heaters with water.
- H. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 1116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Where installing piping adjacent to electric, 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 23 0553 "Identification for Mechanical."

3.4 FIELD QUALITY CONTROL

- A. 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.
 - 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 operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 4000 "Quality Requirements" for retesting and reinspecting requirements and Section 01 7300 "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters.

3.6 COMMISSIONING

- A. Provide support for commissioning activities and functional performance testing as outlined in Section 01 9113 "General Commissioning Requirements"

END OF SECTION 22 3300

SECTION 22 4100
PLUMBING SPECIALTIES

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 plumbing specialties:

1. Backflow preventers.
2. Strainers.
3. Outlet boxes.
4. Wall hydrants.
5. Trap seal priming systems.
6. Drain valves.
7. Miscellaneous piping specialties.
8. Cleanouts.
9. Floor drains.
10. Trench drains.
11. Balancing valves.

- B. Related Sections include the following:

1. Section 23 0519 "Meters and Gages for Mechanical Piping" for water meters, thermometers, and pressure gages.
2. Section 22 1116 "Domestic Water Piping" for water supply to fixtures and equipment.
3. Section 22 1316 "Sanitary Waste and Vent Piping" for sanitary connections to fixtures and equipment.
4. Section 22 1413 "Storm Drainage Piping" for connections to storm water system.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:

1. Domestic Water Piping: 125 psig.
2. Sanitary Waste and Vent Piping: 10-foot head of water.
3. Storm Drainage Piping: 10-foot head of water.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following:

1. Backflow preventers.
2. Strainers.
3. Water hammer arresters and trap seal priming devices and systems.
4. Drain valves, hose bibbs, and hydrants.
5. Outlet boxes and accessories.
6. Cleanouts, floor drains, and trench drains.

B. Field test reports.

C. Maintenance Data: For plumbing specialties to include in maintenance manuals. Include the following:

1. Backflow preventers.
2. Trap seal priming devices and/or systems.
3. Hydrants.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of plumbing specialties and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.

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. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.

E. NSF Compliance:

1. All piping, fittings, valves and other components installed within a potable water distribution system shall comply with NSF 61 "Drinking Water System Components-Health Effects."
2. In the State of Maryland, all piping, fittings, valves and other components installed within a potable water system intended for human consumption shall comply with NSF 61 Annex G "Drinking Water System Components-Lead Content" or NSF 372 "Drinking Water System Components-Lead Content." Lead content shall comply with regulation .03 under COMAR 09.20.01 State Plumbing Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 BACKFLOW PREVENTERS

- A. Manufacturers:
1. Ames Fire and Waterworks, a Division of Watts Water Technologies, Inc.
 2. Febco Backflow Preventers; a Division of Watts Water Technologies, Inc.
 3. Conbraco Industries, Inc.
 4. Watts Industries, Inc.; a Division of Watts Water Technologies, Inc.; Watts Regulator Co.
 5. Zurn Industries, Inc.; Plumbing Products Group, Wilkins Water Control Products.
 6. Flowmatic Corporation.
- B. General: ASSE standard, backflow preventers.
1. NPS 2 and Smaller: Bronze body with threaded ends.
 2. NPS 2-1/2 and Larger: Bronze, cast-iron, steel, or stainless-steel body with flanged ends.
 - a. Interior Lining: AWWA C550 or FDA-approved, for backflow preventers having cast-iron or steel body.
 3. Interior Components: Corrosion-resistant materials.
 4. Exterior Finish: Polished chrome plate if used in chrome-plated piping system.
 5. Strainer: On inlet.
- C. Double-Check Backflow Prevention Assemblies: ASSE 1015, suitable for continuous pressure application. Include shutoff valves on inlet and outlet, and strainer on inlet; test cocks; and two positive-seating check valves. When installed in a fire protection supply system, shut-off valves shall be "indicating valves" in accordance with NFPA requirements.
1. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
- D. Dual-Check-Valve-Type Backflow Preventers: ASSE 1024, suitable for continuous pressure application. Include union inlet and two independent check valves.

2.3 STRAINERS FOR DOMESTIC WATER SYSTEMS

- A. Strainers: Y-pattern, unless otherwise indicated, and full size of connecting piping. Include ASTM A 666, Type 304, stainless-steel screens with 3/64-inch round perforations, unless otherwise indicated.
1. Pressure Rating: 125-psig minimum working pressure, unless otherwise indicated.
 2. NPS 2 and Smaller: Bronze body, with threaded ends.

3. NPS 2-1/2 and Larger: Cast-iron body, with interior AWWA C550 or FDA-approved, epoxy coating and flanged ends.
4. Y-Pattern Strainers: Screwed screen retainer with centered blowdown.
 - a. Drain: Factory- or field-installed, hose-end drain valve.

2.4 OUTLET BOXES

A. Icemaker Outlet Boxes (P-7):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. IPS Corporation.
 - c. Oatey.
 - d. Guy Gray Manufacturing Co., Inc.
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. with ASSE 1024 dual check valve backflow preventer.
5. Supply Shutoff Fitting: NPS 1/2 ball valve and NPS 1/2 copper, water tubing.
6. Water Hammer Arrester: ASSE 1010.
7. Reinforcement: 2 by 4-inch fire retardant treated wood blocking between studs. Fire retardant treated wood blocking is specified in Division 6.

2.5 NON-FREEZE WALL HYDRANTS

A. Manufacturers:

1. Josam Co.; Series.
2. Smith, Jay R. Mfg. Co.
3. Watts Industries, Inc.; Drainage Products Div.
4. Woodford Manufacturing Co.
5. Zurn Industries, LLC; Plumbing Products Group.

B. Standard: ASME A112.21.3M, for concealed-outlet, self-draining wall hydrant.

1. Inlet: NPS 3/4 threaded.
2. Outlet: 3/4" garden-hose threads.
3. Operating Keys: Two with each key-operation hydrant.
4. Pressure Rating: 125 psig.

C. Nonfreeze Concealed-Outlet Wall Hydrants: ASSE 1019-B, self-drainable with flush-mounting box with cover, integral nonremovable hose-connection vacuum breaker, casing and operating rod to match wall thickness, concealed outlet, and wall clamp.

1. Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
2. Box and Cover Finish: Nickel bronze.

2.6 TRAP SEAL PRIMING SYSTEMS

- A. Supply-Type Trap Seal Priming Device: Water-supply-fed type, with the following characteristics:
1. Manufacturers:
 - a. Precision Plumbing Products, Inc.
 - b. Josam Co.
 - c. Smith, Jay R. Mfg. Co.
 - d. Watts Industries, Inc.
 - e. Zurn Industries, Inc.
 2. Standard: ASSE 1018.
 3. 125-psig maximum working pressure.
 4. Bronze body with atmospheric-vented drain chamber.
 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.
 8. Integral vacuum breaker.
- B. Automatic Trap Seal Priming System: Factory-fabricated, automatic-operation assembly with the following:
1. Manufacturers:
 - a. Precision Plumbing Products, Inc.
 - b. Zurn Industries, Inc.
 2. Standard: ASSE 1044.
 3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing inlet and calibrated manifold with number of NPS 1/2 outlets as indicated or required.
 4. Cabinet: Surface-mounted 16 gage steel box with stainless-steel hinged, lockable door.
 5. Electric Controls: 24-hour timer, solenoid valve, circuit breaker and manual override switch for 120-V ac power.
 - 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.
 6. Water Hammer Arrester: ASSE 1010.
 7. Anti-siphon Atmospheric Vacuum Breaker: ASSE 1001

2.7 DRAIN VALVES

- A. Hose-End Drain Valves: MSS SP-110, NPS 3/4 ball valve, rated for 400-psig minimum CWP. Include two-piece, copper-alloy body with standard port, chrome-plated brass ball, replaceable seats and seals, blowout-proof stem, and vinyl-covered steel handle.

1. Inlet: Threaded or solder joint.
2. Outlet: Short-threaded nipple with ASME B1.20.7, integral vacuum breaker, garden-hose threads and cap.

2.8 MISCELLANEOUS PIPING SPECIALTIES

- A. Water Hammer Arresters: ASSE 1010 or PDI-WH 201, metal-bellows type with pressurized metal cushioning chamber or piston type with pressurized metal-tube cushioning chamber. Sizes indicated are based on ASSE 1010 or PDI-WH 201, Sizes A through F.
1. Manufacturers:
 - a. Josam Co.
 - b. Smith, Jay R. Mfg. Co.
 - c. Zurn Industries, Inc.; Specification Drainage Operation.
 - d. Precision Plumbing Products, Inc.
- B. Hose Bibbs: Bronze body with replaceable seat disc complying with ASME A112.18.1M for compression-type faucets. Include NPS 1/2 or NPS 3/4 threaded or solder-joint inlet, of design suitable for pressure of at least 125 psig; integral nonremovable, drainable hose-connection vacuum breaker complying with ASSE 1011; and garden-hose threads complying with ASME B1.20.7 on outlet.
1. Finish for Equipment Rooms: Rough bronze.
 2. Operation for Equipment Rooms: Wheel handle or operating key.
 3. Include operating key with each operating-key hose bibb.
 4. Include integral wall flange with each chrome- or nickel-plated hose bibb.
- C. Fixture Air-Admittance Valves: Plastic housing with mechanical-operation sealing diaphragm, designed to admit air into drainage and vent piping and to prevent transmission of sewer gas into building.
1. Manufacturers:
 - a. Studor, Inc.
 - b. B & K Industries, Inc.
 - c. Durgo, Inc.
 - d. Proset Systems, Inc.
 - e. IPS Corporation.
 - f. Sioux Chief Manufacturing Co., Inc.
 2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
- D. Deep-Seal Traps: Cast-iron or bronze casting, with inlet and outlet matching connected piping and trap seal priming connection.
1. NPS 2: 4-inch- minimum water seal.
 2. NPS 2-1/2 and Larger: 4-inch- minimum water seal.
- E. Floor/Trench-Drain Inlet Fittings: Cast iron, with threaded inlet and threaded or spigot outlet, and trap seal primer valve connection.

- F. Fixed Air-Gap Fittings: Manufactured cast-iron or bronze drainage fitting with semi-open top with threads or device to secure drainage inlet piping in top and bottom spigot or threaded outlet larger than top inlet. Include design complying with ASME A112.1.2 that will provide fixed air gap between installed inlet and outlet piping.

2.9 CLEANOUTS

- A. Cleanouts: Comply with ASME A112.36.2M, cast-iron cleanouts.

- 1. Application: Floor cleanout.
- 2. Manufacturers:
 - a. Josam Co., Series 55000.
 - b. Zurn Industries, Inc., Specification Drainage Operation.
 - c. Smith, Jay R. Mfg. Co.
 - d. Watts Industries, Inc., Drainage Products Div.
- 3. Body or Ferrule Material: Cast iron.
- 4. Clamping Device: Required.
- 5. Outlet Connection: Gasketed hub and/or no-hub.
- 6. Closure: Brass plug with tapered threads.
- 7. Adjustable Housing Material: Cast iron with threads.
- 8. Frame and Cover Material and Finish: Polished bronze.
- 9. Frame and Cover Shape: Round.
- 10. Top Loading Classification: Medium Duty.
- 11. Vandal-proof screws.

- B. Cleanouts: Comply with ASME A112.36.2M.

- 1. Application: Wall cleanout.
- 2. Manufacturers:
 - a. Josam Co., Series 58600 - COT
 - b. Zurn Industries, Inc., Specification Drainage Operation.
 - c. Smith, Jay R. Mfg. Co.
 - d. Watts Industries, Inc., Drainage Products Div. Oper.
- 3. Body or Ferrule Material: Cast iron.
- 4. Outlet Connection: Gasketed hub and/or no-hub.
- 5. Closure: Threaded countersunk threaded bronze plug.
- 6. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
- 7. Frame and Cover Material and Finish: Stainless steel.
- 8. Frame and Cover Shape: Round.
- 9. Vandal-proof secured top.

- C. Cleanouts: Comply with ASME A112.36.2M.

- 1. Application: For installation in exposed piping.
- 2. Manufacturers:
 - a. Josam Co., Series 58540.
 - b. Zurn Industries, Inc., Specification Drainage Operation.
 - c. Smith, Jay R. Mfg. Co.

- d. Watts Industries, Inc., Drainage Products Div.
 3. Closure: Brass plug with straight threads and gasket, round brass plug with threads, and countersunk opening.
- 2.10 FLOOR DRAINS
- A. Floor Drains, Type "A": Comply with ASME A112.6.3.
1. Application: Floor drain, toilet rooms.
 2. Manufacturers:
 - a. Josam Co., Series 30000-A.
 - b. Zurn Industries, Inc., Specification Drainage Operation.
 - c. Smith, Jay R. Mfg. Co.
 - d. Watts Industries, Inc., Drainage Products Div.
 3. Body Material: Gray iron with trap seal priming connection.
 4. Seepage Flange: Required.
 5. Clamping Device: Required.
 6. Outlet: Bottom, gasketed hub.
 7. Top or Strainer Material: Nickel bronze.
 8. Top Shape: Round.
 9. Dimensions of Top or Strainer: 8" adjustable.
 10. Top Loading Classification: Medium Duty.
 11. Trap Material: Cast iron.
 12. Trap Pattern: Deep-seal P-trap.
 13. Vandal-proof screws.
 14. Funnel: Not required
- B. Floor Drains, Type "B": Comply with ASME A112.6.3.
1. Application: Floor drain for Mechanical Equipment Rooms.
 2. Manufacturers:
 - a. Josam Co., Series 32100.
 - b. Zurn Industries, Inc., Specification Drainage Operation.
 - c. Smith, Jay R. Mfg. Co.
 - d. Watts Industries, Inc., Drainage Products Div.
 3. Body Material: Gray iron, with trap seal priming connection.
 4. Seepage Flange: Required.
 5. Clamping Device: Required.
 6. Outlet: Bottom, gasketed hub.
 7. Top or Strainer Material: Gray iron.
 8. Top Shape: Round.
 9. Dimensions of Top or Strainer: 9".
 10. Top Loading Classification: Heavy Duty.
 11. Trap Material: Cast iron.
 12. Trap Pattern: Deep-seal P-trap.
 13. Vandal-proof screws.
- C. Floor Drains, Type "C": Comply with ASME A112.6.3.

1. Application: Floor drain with funnel in mechanical rooms.
2. Manufacturers:
 - a. Josam Co., Series 32100-F4.
 - b. Zurn Industries, Inc., Specification Drainage Operation.
 - c. Smith, Jay R. Mfg. Co.
 - d. Watts.
3. Body Material: Gray iron, with trap seal priming connection.
4. Seepage Flange: Required.
5. Clamping Device: Required.
6. Outlet: Bottom, gasketed hub.
7. Top or Strainer Material: Nickel bronze with strainer with round funnel.
8. Top Shape: Round.
9. Dimensions of Top or Strainer: 7" adjustable with extension.
10. Top Loading Classification: Medium Duty.
11. Trap Material: Cast iron.
12. Trap Pattern: Deep-seal P-trap.
13. Vandal-proof screws.

2.11 TRENCH DRAINS

A. Trench Drains, Type "D": Comply with ASME A112.6.3.

1. Application: Mechanical equipment room.
2. Manufacturers:
 - a. Josam Co., Series 76010.
 - b. Smith, Jay R. Mfg. Co.
 - c. Watts Drainage.
 - d. Zurn Industries, Inc.,
3. Body Material: Gray Iron.
4. Seepage Flange: Required.
5. Clamping Device: Required.
6. Outlet: Bottom, no-hub or hub connection.
7. Grate Material: Gray Iron.
8. Grate Finish: Dura-coated cast iron
9. Dimensions of Frame and Grate: One (1) 15" long by 12" wide section, with 4" diameter drain outlet.
10. Top Loading Classification: Heavy Duty.
11. Trap Material: Cast iron.
12. Trap Pattern: Deep seal P-trap with trap seal priming connection.
13. Vandal Proof Screws.

2.12 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.

- b. ITT Corporation; Bell & Gossett Div.
 - c. NIBCO Inc.
 - d. TACO Incorporated.
 - e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
 3. Body: Brass or bronze.
 4. Size: Same as connected piping, but not larger than NPS 2.
 5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Section 230500 "Common Work Results for Mechanical" for piping joining materials, joint construction, and basic installation requirements.
- B. 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 not acceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- C. Install strainers on supply side of each backflow preventer, and where indicated.
- D. Install trap seal priming devices with outlet piping pitched down toward drain trap a minimum of 1 percent and connect to floor-drain body, trap, or inlet fitting. Adjust for proper flow.
- E. 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.
- F. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.
- G. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
- H. 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. 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.
 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
 5. Install trap priming line to floor drain traps.
- I. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.
 - J. Fasten recessed-type plumbing specialties to reinforcement built into walls.
 - K. Install wood-blocking reinforcement for wall-mounting and recessed-type plumbing specialties.
 - L. Install individual shutoff valve in each water supply to plumbing specialties. Use ball valve if specific valve is not indicated. Install shutoff valves in accessible locations. Refer to Section 23 0523 "General-Duty Valves for Mechanical Piping" for general-duty ball, butterfly, check, gate, and globe valves.
 - M. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
 - N. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.
- ### 3.2 CONNECTIONS
- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - B. Install piping adjacent to equipment to allow service and maintenance.
 - C. Connect plumbing specialties to piping specified in other Division 22 and 23 Sections.
 - D. Ground equipment.
 - E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
 - F. Connect plumbing specialties and devices that require power according to Division 26 Sections.

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each backflow preventer thermostatic water mixing valve water tempering valve trap seal primer system.
 - 1. Text: 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.
 - 2. Refer to Section 230700 "Identification for Mechanical" for nameplates and signs.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled trap seal primer systems and their installation, including piping and electrical connections. Report results in writing.
 - 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.

3.5 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain trap seal primer systems. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 22 4100

SECTION 22 4213.13

COMMERCIAL WATER CLOSETS

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. Water closets.
2. Flushometer valves.
3. Toilet seats.

- B. Related Requirements:

1. Section 22 1116 "Domestic Water Piping" for water supply to water closets.
2. Section 22 1316 "Sanitary Waste and Vent Piping" for connections to water closets.

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. LEED Submittals:

1. Product Data for Prerequisite WE 1, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
2. Product Data for Prerequisite WE 1: Documentation indicating flow and water consumption requirements.
3. Product Data for Prerequisite WE 1 and Credit WE 2: Documentation indicating flow and water consumption requirements.

- C. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

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] <Insert number> percent of amount of each type installed, but no fewer than [one] [six] <Insert number> of each type.

1.6 QUALITY ASSURANCE

- A. All piping, fittings, valves and other components installed within a potable water distribution system shall comply with NSF 61 "Drinking Water System Components-Health Effects."
- B. In the State of Maryland, all piping, fittings, valves and other components installed within a potable water system intended for human consumption shall comply with NSF 61 Annex G "Drinking Water System Components-Lead Content" or NSF 372 "Drinking Water System Components-Lead Content." Lead content shall comply with regulation .03 under COMAR 09.20.01 State Plumbing Code.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

- A. Water Closets P-1: Floor mounted, bottom outlet, top spud, high efficiency, accessible.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. TOTO USA, INC.
 - c. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - d. Sloan.
 - e. Kohler.
 - 2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flushometer valve.
 - e. Height: Standard.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.28 gal. per flush.
 - h. Spud Size and Location: NPS 1-1/2; top.
 - i. Color: White.
 - 3. Bowl-to-Drain Connecting Fitting: ASTM A 1045 or ASME A112.4.3.
 - 4. Flushometer Valve: Specified herein.
 - 5. Toilet Seat: Specified herein.
- B. Water Closets P-1A: Floor mounted, bottom outlet, high efficiency, flush tank, accessible.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. TOTO USA, INC.
 - c. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - d. Sloan.
 - e. Kohler.
2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flush tank.
 - e. Height: Standard.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.28 gal. per flush.
 - h. Color: White.
3. Bowl-to-Drain Connecting Fitting: ASTM A 1045 or ASME A112.4.3.
4. Toilet Seat: Specified herein.

2.2 FLUSHOMETER VALVES

A. Solenoid-Actuator, Diaphragm Flushometer Valves P-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sloan Valve Company.
 - b. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - c. Delany Co.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device. Include with spud coupling with flange and sweat solder adapter with cover tube and cast wall flange with set screw.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Free spinning vandal resistant stop cap.
8. Panel Finish: Chrome plated or stainless steel.
9. Style: Exposed.
10. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
11. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
12. Consumption: 1.28 gal. per flush.
13. Minimum Inlet: NPS 1.
14. Minimum Outlet: NPS 1-1/4.

15. Courtesy flush override button.
16. Where indicated on contract documents, flush valve tailpiece to have adapter for trap priming supply to floor drains.

2.3 TOILET SEATS

A. Toilet Seats P-1 and P-1A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bemis Manufacturing Company, Model #2155SSCT.
 - b. Church Seats.
 - c. Olsonite Seat Co.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic, with antimicrobial coating.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Self-sustaining, check.
7. Hinge Material: Stainless steel.
8. Seat Cover: Not required.
9. Color: White.

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 water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. 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.

B. Support Installation:

1. Install floor-mounted, water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.

3. Install actuators in locations that are easy for people with disabilities to reach.
 - D. Install toilet seats on water closets.
 - E. 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 23 0500 "Common Work Results for Mechanical."
 - F. Joint Sealing:
 1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 2. Match sealant color to water-closet color.
 3. Comply with sealant requirements specified in Section 07 9200 "Joint Sealants."
- 3.3 CONNECTIONS
- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
 - B. Comply with water piping requirements specified in Section 22 1116 "Domestic Water Piping."
 - C. Comply with soil and waste piping requirements specified in Section 22 1316 "Sanitary Waste and Vent Piping."
 - D. Where installing piping adjacent to water closets, allow space for service and maintenance.
- 3.4 ADJUSTING
- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
 - B. Adjust water pressure at flushometer valves to produce proper flow.
- 3.5 CLEANING AND PROTECTION
- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
 - B. Install protective covering for installed water closets and fittings.
 - C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 4213.13

SECTION 22 4216.13
COMMERCIAL LAVATORIES

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. Lavatories.
- 2. Faucets.
- 3. Fixture supports.
- 4. Supply fittings.
- 5. Waste fittings.
- 6. Protective shielding guards.
- 7. Thermostatic mixing valves.

B. Related Requirements:

- 1. Section 22 1116 "Domestic Water Piping" for water supply to lavatories.
- 2. Section 22 1316 "Sanitary Waste and Vent Piping" for connections to lavatories.

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 lavatories.
- 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittals:

- 1. Product Data for Prerequisite WE 1, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
- 2. Product Data for Prerequisite WE 1: Documentation indicating flow and water consumption requirements.
- 3. Product Data for Prerequisite WE 1 and Credit WE 2: Documentation indicating flow and water consumption requirements.

C. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.
 - 1. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:
 - a. Servicing and adjustments of automatic faucets.

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. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

1.6 QUALITY ASSURANCE

- A. All piping, fittings, valves and other components installed within a potable water distribution system shall comply with NSF 61 "Drinking Water System Components-Health Effects."
- B. In the State of Maryland, all piping, fittings, valves and other components installed within potable water system intended for human consumption shall comply with NSF 61 Annex G "Drinking Water System Components-Lead Content" or NSF 372 "Drinking Water System Components-Lead Content." Lead content shall comply with regulation .03 under COMAR 09.20.01 State Plumbing Code.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

- A. Lavatory P-2: Vitreous china, wall mounted, with self-draining area with contoured back and side shields .
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard model Lucerne
 - b. Kohler Co.
 - c. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - d. Sloan.
 - e. Toto
 - 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For wall hanging with concealed arms.

- c. Nominal Size: 19 by 16 inches.
 - d. Faucet-Hole Punching: One hole.
 - e. Faucet-Hole Location: Top ledge.
 - f. Color: White.
 - g. Mounting Material: Chair carrier.
- 3. Faucet: Specified herein.
 - 4. Support: Specified herein.

2.2 SOLID-BRASS, SENSOR OPERATED LAVATORY FAUCETS

- A. Lavatory Faucets P-2 & P-2A: Sensor-type, hard-wired, electronic-sensor-operated, nonmixing, solid-brass valve.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradley Corporation.
 - b. Chicago Faucets.
 - c. Moen Commercial.
 - d. Sloan Valve Company.
 - e. Speakman Company.
 - f. TOTO USA, INC.
 - g. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - 2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
 - 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.
 - 4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 - 5. Body Type: Single hole.
 - 6. Body Material: Commercial, solid brass.
 - 7. Finish: Polished chrome plate.
 - 8. Maximum Flow Rate: 0.5 gpm.
 - 9. Mounting Type: Back/wall, concealed.
 - 10. Spout: Rigid type.
 - 11. Spout Outlet: Spray.
 - 12. Drain: Not part of faucet.
 - 13. Accessible.
 - 14. Transformer: Required.

2.3 SUPPLY FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. McGuire Manufacturing Co. Model #**LF-167 LK = 3/8" x 1/2.**
 - 2. Engineered Brass Company.
 - 3. Brasscraft.
 - 4. Chicago.
- B. Standard: ASME A112.18.1/CSA B125.1.

- C. Supply Piping: Lead-free 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: Lead-free 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. Lead-free chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces riser.

2.4 WASTE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. McGuire Manufacturing Co. #C8912.
 - 2. Chicago.
 - 3. Engineered Brass Company.
 - 4. Brasscraft.
- B. Standard: ASME A112.18.2/CSA B125.2.
- C. Drain: Grid type with NPS 1-1/4 straight tailpiece.
- D. 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.

2.5 FIXTURE SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Josam Series 17100.
 - 2. Smith, Jay R.
 - 3. Zurn.
 - 4. Watts.
- B. Lavatory Supports, P-2.
 - 1. Description: ASME A112.6.1M, Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include rectangular steel uprights with feet.
 - 2. Accessible-Fixture Support: Include rectangular steel uprights.

2.6 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers, P-2 & P-2A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGuire Manufacturing Co.
 - b. Engineered Brass Company.
 - c. Plumberex.
 - d. Truebro: a brand of IPS Corporation.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.7 THERMOSTATIC MIXING VALVES

- A. Thermostatic Mixing Valve (HWMV-2): ASSE 1070 Certified, lead-free solid bronze construction with advanced thermal actuator for low flow performance (0.5 GPM), adjustable temperature selection with lock-down capabilities, union connections for easy maintenance and with integral check-stops and screens for preventing cross-flow and contamination.
 1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
 - a. Powers Model LFLM495
 - b. Lawler
 - c. Symmons.
 - d. Leonard Valve Co.
 - e. Acorn.
 2. Where indicated on the drawings and required, mixing valves shall be provided within recessed cabinets with flange. Cabinets shall be stainless steel with hinged lockable door. Cabinets shall be provided with inlet/outlet knock-out holes for mounting flexibility.

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 lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install lavatories level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.

- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 23 0500 "Common Work Results for Mechanical."
- E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 9200 "Joint Sealants."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories.

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 1116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 1316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 4216.13

SECTION 22 4216.16

COMMERCIAL SINKS

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. Mop receptors.
2. Stainless steel sinks.
3. Sink faucets.
4. Supply fittings.
5. Waste fittings.
6. Fixture supports.

B. Related Requirements:

1. Section 22 1116 "Domestic Water Piping" for water supply connections to sinks.
2. Section 22 1316 "Sanitary Waste and Vent Piping" for sanitary waste and vent connections to sinks.

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 sinks.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. LEED Submittals:

1. Product Data for Prerequisite WE 1, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
2. Product Data for Prerequisite WE 1: Documentation indicating flow and water consumption requirements.
3. Product Data for Prerequisite WE 1 and Credit WE 2: Documentation indicating flow and water consumption requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sinks 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. Faucet Washers and O-Rings: One of each type and size installed.
 - 2. Faucet Cartridges and O-Rings: One of each type and size installed.

1.6 QUALITY ASSURANCE

- A. All piping, fittings, valves and other components installed within a potable water distribution system shall comply with NSF 61 "Drinking Water System Components-Health Effects."
- B. In the State of Maryland, all piping, fittings, valves and other components installed within a potable water system intended for human consumption shall comply with NSF 61 Annex G "Drinking Water System Components-Lead Content" or NSF 372 "Drinking Water System Components-Lead Content." Lead content shall comply with regulation .03 under COMAR 09.20.01 State Plumbing Code.

PART 2 - PRODUCTS

2.1 MOP RECEPTORS

- A. Mop Receptors P-8: Terrazzo, floor mounted.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. Crane Plumbing, L.L.C.
 - c. Florestone Products Co., Inc.
 - d. Stern-Williams Co., Inc.
 - 2. Fixture:
 - a. Standard: IAPMO PS 99.
 - b. Shape: Five sided.
 - c. Nominal Size: 24 by 24 inches.
 - d. Height: 12 inches with dropped front.
 - e. Tiling Flange: On two sides.
 - f. Rim Guard: On front top surfaces.
 - g. Color: Not applicable.
 - h. Drain: Grid with NPS 3 outlet.
 - 3. Mounting: On floor and flush to wall.
 - 4. Faucet: Specified herein.

2.2 STAINLESS STEEL SINKS

- A. Kitchenette Sink P-6: Stainless steel, counter mounted, double compartment, accessible.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Tabco.
 - b. Elkay Manufacturing Co.
 - c. Just Manufacturing.
 - d. Amtekco Industries, Inc.
2. Fixture:
 - a. Standard: ASME A112.19.3/CSA B45.4.
 - b. Type: Ledge back.
 - c. Number of Compartments: One.
 - d. Overall Dimensions: <Insert dimensions>.
 - e. Material: Seamless die-drawn construction of 18 gauge, type 304, 18-8 stainless steel. Interior surfaces shall be polished to a non-porous finish, with fully coated underside.
 - f. Each Compartment:
 - 1) Dimensions: <Insert dimensions>.
 - 2) Drains: Grid with NPS 1-1/2 tailpiece and twist drain.
 - 3) Drain Location: Centered in compartment.
3. Faucet(s): Specified herein.
 - a. Number Required: One.
 - b. Mounting: On ledge.
4. Supply Fittings: Specified herein.
5. Waste Fittings: Specified herein.
6. Mounting: On counter with sealant.

2.3 SINK FAUCETS

- A. Sink Faucets P-6: Manual type, two-lever-handle mixing valve.
 1. Commercial, Solid-Brass Faucets.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Chicago Faucets.
 - 2) Moen Commercial.
 - 3) Speakman Company.
 - 4) Zurn Plumbing Products Group.
 - 5) Sloan.
 2. Standard: ASME A112.18.1/CSA B125.1.
 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
 4. Body Type: Widespread.
 5. Body Material: Commercial, solid brass, lead-free.
 6. Finish: Polished chrome plate.
 7. Maximum Flow Rate: 1.5 gpm.
 8. Handle(s): Wrist blade, 4 inches.
 9. Mounting Type: Deck, concealed.
 10. Spout Type: Swivel gooseneck.

11. Vacuum Breaker: Not required.
- A. Sink Faucets, P-8: Manual type, two-lever-handle mixing valve, commercial, solid-brass faucets.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - a. Speakman Model SEF-9000-TW.
 - b. Chicago Faucets.
 - c. Moen Commercial.
 - d. Zurn Plumbing Products Group.
 - e. Sloan.
 2. Description: Barrier free, Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout with integral vacuum breaker and hose thread outlets and fixture receptor. Faucet shall include emergency eye wash feature with integral mixing valve to deliver ANSI Z358.1 tepid water.
 - a. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
 - b. Body Material: Cast brass.
 - c. Finish: Polished chrome plate.
 - d. Type: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, emergency eye wash, and pail hook.
 - e. Mixing Valve: Two-lever handle.
 - 1) Centers: 8 inches.
 - 2) Mounting: On wall, exposed.
 - f. Handles: Lever.
 - g. Inlets: NPS ½ female shank.
 - h. Spout: Rigid, cast with wall brace.
 - i. Spout Outlet: Hose thread.
 - j. Vacuum Breaker: Required.
 - k. Operation: Noncompression, manual.
 - l. Eyewash: ANSI Z358.1 certified.
 - m. Thermostatic mixing valve: ASSE 1071 Certified internal cold-water by pass system to ensure flow in the event of valve failure or loss of hot water supply. Supply valve also includes temperature/pressure gauge for diagnostics. The valve shall provide precise temperature control over a wide range of flow conditions, and effectively shut down on loss of cold water. The valve shall feature liquid filled thermostatic motor. and checkstops to prevent cross flow. The valve shall be factory set to 85°F with a lockable mean of securing the temperature

2.4 SUPPLY FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. McGuire Manufacturing Co., Model #LF2167LK = 1/2" x 1/2".
 2. Chicago.
 3. Engineered Brass Co.
 4. Brasscraft.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Lead-free 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: Lead-free 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. Lead-free chrome-plated, rigid-copper pipe.

2.5 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. McGuire Manufacturing Co.
 - 2. Chicago.
 - 3. Engineered Brass Co.
 - 4. Brasscraft.
- C. Drain: Grid type with NPS 1-1/2 straight tailpiece.
- D. Trap:
 - 1. Size: NPS 1-1/2.
 - 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.

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 sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- D. Set floor-mounted sinks in leveling bed of cement grout.

- E. Install water-supply piping with stop on each supply to each sink faucet.
 - 1. Exception: Use ball, gate, or globe valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 23 0519 "General-Duty Valves for Mechanical Piping."
 - 2. Install stops in locations where they can be easily reached for operation.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 23 0500 "Common Work Results for Mechanical."
- G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 9200 "Joint Sealants."
- H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 23 0700 "Mechanical Insulation."

3.3 CONNECTIONS

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 1116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 1316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 4216.16

SECTION 22 4223
COMMERCIAL SHOWERS

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. Shower receptors.
 - 2. Mixing Valve/Controls.
- B. Related Sections include the following:
 - 1. Section 22 1116 "Domestic Water Piping" for water supply to showers.
 - 2. Section 22 1316 "Sanitary Waste and Vent Piping" for connections to showers.

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 showers.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. LEED Submittals:
 - 1. Product Data for Prerequisite WE 1 and Credit WE 2: Documentation indicating flow and water consumption requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For bathtub/shower Mixing Valves/Controls 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. Mixing Valve/Control Washers and O-Rings: One of each type and size installed.
 - 2. Mixing Valve/Control Cartridges and O-Rings: One of each type and size installed.

1.6 QUALITY ASSURANCE

- A. All piping, fittings, valves and other components installed within a potable water distribution system shall comply with NSF 61 "Drinking Water System Components-Health Effects."

- B. All piping, fittings, valves and other components installed within a potable water system intended for human consumption shall comply with NSF 61 Annex G "Drinking Water System Components-Lead Content" or NSF 372 "Drinking Water System Components-Lead Content."

PART 2 - PRODUCTS

2.1 INDIVIDUAL SHOWERS

- A. Shower, P-4: Acrylic shower enclosure with slip-resistant bathing surface.
1. Manufacturers:
 - a. Aquarius
 - b. Aqua Bath.
 - c. Fiat.
 - d. Acryline.
 2. Size: 36 by 36 by 84 inches.
 3. Surround: One piece.
 4. Color: White.
 5. Drain Location: Center.
 6. Include grab bars and full length fold-up seat
 7. Faucet: As specified herein.
 8. Drain: Grid, NPS 2.
 9. Provide with rod and curtain

2.2 MIXING VALVES / CONTROLS

- A. Shower Mixing valves, P-4:
1. Manufacturers:
 - a. Powers; a Watts Industries Co.
 - 1) Valve: HydroGuard, Series e705
 - 2) Showerhead: Part no. 141-150
 - b. Symmons Industries, Inc.
 - c. Speakman
 - d. Chicago Faucets.
 - e. Leonard Valve Company
 2. Description: ASSE 1016 single-handle temperature and pressure-balance valve. Include hot- and cold-water indicators; check stops; and hand-held showerhead, arm, and flange. Coordinate mixing valve inlets with supplies.
 - a. Body Material: Solid brass with nonmetallic trim.
 - b. Finish: Polished brass.
 - c. Maximum Flow Rate: 1.5 gpm.
 - d. Diverter Valve: Not required.
 - e. Mounting: Concealed.
 - f. Operation: Compression, manual.
 - g. Antiscald Device: Integral with mixing valve.
 - h. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
 - i. Supply Connections: NPS 1/2, union.
 - j. Showerhead Type: Hand held, slide-bar mounted.

- k. Showerhead Material: Combined, metallic and nonmetallic with chrome-plated finish.
- l. Spray Pattern: Adjustable.
- m. Temperature Indicator: Integral with mixing valve.

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 shower installation.
- B. Examine walls and floors for suitable conditions where showers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble shower components according to manufacturers' written instructions.
- B. Install showers level and plumb according to roughing-in drawings.
- C. Install water-supply piping with stop on each supply to each shower mixing valve.
- D. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- E. Set shower receptors in leveling bed of cement grout.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 23 0500 "Common Work Results for HVAC."
- G. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 9200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 1116 "Domestic Water Piping."
- C. Comply with traps and soil and waste piping requirements specified in Section 22 1316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.

- B. Adjust water pressure at mixing valves/controls to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of showers, inspect and repair damaged finishes.
- B. Clean showers and bathtubs, mixing valve/controls, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed fixtures and fittings.
- D. Do not allow use of showers for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 4223

SECTION 22 4500
EMERGENCY PLUMBING FIXTURES

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. Eye/face wash equipment.
 - 2. Water-tempering equipment.
- B. Related Sections include the following:
 - 1. Section 22 1116 "Domestic Water Piping."
 - 2. Section 23 0519 "Meters and Gages for HVAC Piping."
 - 3. Section 23 0553 "Identification for Mechanical."

1.3 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Tepid: Moderately warm.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
- B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

1.7 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. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- C. NSF Standard:
 - 1. All piping, fittings, valves and other components installed within the domestic potable water system shall comply with NSF 61 including Annex G "Drinking Water System Components-Lead Content" or NSF 372 "Drinking Water System Components-Lead Content."
- D. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

2.1 EMERGENCY PLUMBING EQUIPMENT

- A. Eyewash Equipment
 - 1. Standard, Wall Mounted, Plumbed Eye/Face wash Units, P-5
 - 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) Bradley Corporation, Series S19224
 - 2) Acorn Safety; a division of Acorn Engineering Company.
 - 3) Encon Safety Products.
 - 4) Guardian Equipment Co.
 - 5) Haws Corporation.
 - 6) Speakman Company.
 - 7) Stingray
 - b. Capacity: Not less than 3.0 gpm for at least 15 minutes.
 - c. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 - d. Control-Valve Actuator: Paddle.
 - e. Spray-Head Assembly: Two receptor-mounted spray heads.
 - f. Receptor: Stainless Steel.
 - g. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 - h. Drain Piping: NPS 1-1/2 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2
 - i. Mounting: Wall.

2.2 WATER-TEMPERING EQUIPMENT

A. Emergency Thermostatic Mixing Valve, HWMV-3

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Powers; a division of Watts Water Technologies, Inc.
 - b. Lawler Manufacturing Co..
 - c. Bradley Corporation
 - d. Leonard Valve Company.
 - e. Speakman Company.
 - f. Stingray
 - g. Acorn
 - h. Symmons
2. Description: Factory-fabricated equipment with thermostatic mixing valve.
 - a. ASSE 1071 Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water to emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, integral check valves and strainers, controls, metal piping, and thermometer.
 - b. Supply Connections: For hot and cold water.
 - c. Cabinet: Surface mounted.
 - 1) Provide 18 ga. stainless steel body and hinged door
 - 2) Cylinder Lock
 - 3) Inlet and outlet knockout holes.
 - 4) Mounting accessories.

2.3 SOURCE QUALITY CONTROL

- A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.

- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures. Use ball valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Division 23 Section "General Duty Valves for Mechanical Piping."
 - 1. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
- E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 22 1116 "Domestic Water Piping."
- F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 23 0519 "Meters and Gages for HVAC Piping."

3.3 CONNECTIONS

- A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 22 1116 "Domestic Water Piping."
- B. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 23 0553 "Identification for HVAC Piping and Equipment."

3.5 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. 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. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION 22 4500

SECTION 22 4213.13

COMMERCIAL WATER CLOSETS

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. Water closets.
- 2. Flushometer valves.
- 3. Toilet seats.

- B. Related Requirements:

- 1. Section 22 1116 "Domestic Water Piping" for water supply to water closets.
- 2. Section 22 1316 "Sanitary Waste and Vent Piping" for connections to water closets.

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. LEED Submittals:

- 1. Product Data for Prerequisite WE 1, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
- 2. Product Data for Prerequisite WE 1: Documentation indicating flow and water consumption requirements.
- 3. Product Data for Prerequisite WE 1 and Credit WE 2: Documentation indicating flow and water consumption requirements.

- C. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

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] <Insert number> percent of amount of each type installed, but no fewer than [one] [six] <Insert number> of each type.

1.6 QUALITY ASSURANCE

- A. All piping, fittings, valves and other components installed within a potable water distribution system shall comply with NSF 61 "Drinking Water System Components-Health Effects."
- B. In the State of Maryland, all piping, fittings, valves and other components installed within a potable water system intended for human consumption shall comply with NSF 61 Annex G "Drinking Water System Components-Lead Content" or NSF 372 "Drinking Water System Components-Lead Content." Lead content shall comply with regulation .03 under COMAR 09.20.01 State Plumbing Code.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

- A. Water Closets P-1: Floor mounted, bottom outlet, top spud, high efficiency, accessible.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. TOTO USA, INC.
 - c. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - d. Sloan.
 - e. Kohler.
 - 2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flushometer valve.
 - e. Height: Standard.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.28 gal. per flush.
 - h. Spud Size and Location: NPS 1-1/2; top.
 - i. Color: White.
 - 3. Bowl-to-Drain Connecting Fitting: ASTM A 1045 or ASME A112.4.3.
 - 4. Flushometer Valve: Specified herein.
 - 5. Toilet Seat: Specified herein.
- B. Water Closets P-1A: Floor mounted, bottom outlet, high efficiency, flush tank, accessible.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. TOTO USA, INC.
 - c. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - d. Sloan.
 - e. Kohler.
2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flush tank.
 - e. Height: Standard.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.28 gal. per flush.
 - h. Color: White.
3. Bowl-to-Drain Connecting Fitting: ASTM A 1045 or ASME A112.4.3.
4. Toilet Seat: Specified herein.

2.2 FLUSHOMETER VALVES

A. Solenoid-Actuator, Diaphragm Flushometer Valves P-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sloan Valve Company.
 - b. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - c. Delany Co.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device. Include with spud coupling with flange and sweat solder adapter with cover tube and cast wall flange with set screw.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Free spinning vandal resistant stop cap.
8. Panel Finish: Chrome plated or stainless steel.
9. Style: Exposed.
10. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
11. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
12. Consumption: 1.28 gal. per flush.
13. Minimum Inlet: NPS 1.
14. Minimum Outlet: NPS 1-1/4.

15. Courtesy flush override button.
16. Where indicated on contract documents, flush valve tailpiece to have adapter for trap priming supply to floor drains.

2.3 TOILET SEATS

A. Toilet Seats P-1 and P-1A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bemis Manufacturing Company, Model #2155SSCT.
 - b. Church Seats.
 - c. Olsonite Seat Co.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic, with antimicrobial coating.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Self-sustaining, check.
7. Hinge Material: Stainless steel.
8. Seat Cover: Not required.
9. Color: White.

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 water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. 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.

B. Support Installation:

1. Install floor-mounted, water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.

3. Install actuators in locations that are easy for people with disabilities to reach.
 - D. Install toilet seats on water closets.
 - E. 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 23 0500 "Common Work Results for Mechanical."
 - F. Joint Sealing:
 1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 2. Match sealant color to water-closet color.
 3. Comply with sealant requirements specified in Section 07 9200 "Joint Sealants."
- 3.3 CONNECTIONS
- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
 - B. Comply with water piping requirements specified in Section 22 1116 "Domestic Water Piping."
 - C. Comply with soil and waste piping requirements specified in Section 22 1316 "Sanitary Waste and Vent Piping."
 - D. Where installing piping adjacent to water closets, allow space for service and maintenance.
- 3.4 ADJUSTING
- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
 - B. Adjust water pressure at flushometer valves to produce proper flow.
- 3.5 CLEANING AND PROTECTION
- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
 - B. Install protective covering for installed water closets and fittings.
 - C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 4213.13

SECTION 22 4216.13
COMMERCIAL LAVATORIES

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. Lavatories.
2. Faucets.
3. Fixture supports.
4. Supply fittings.
5. Waste fittings.
6. Protective shielding guards.
7. Thermostatic mixing valves.

B. Related Requirements:

1. Section 22 1116 "Domestic Water Piping" for water supply to lavatories.
2. Section 22 1316 "Sanitary Waste and Vent Piping" for connections to lavatories.

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 lavatories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittals:

1. Product Data for Prerequisite WE 1, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
2. Product Data for Prerequisite WE 1: Documentation indicating flow and water consumption requirements.
3. Product Data for Prerequisite WE 1 and Credit WE 2: Documentation indicating flow and water consumption requirements.

C. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.
 - 1. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:
 - a. Servicing and adjustments of automatic faucets.

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. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

1.6 QUALITY ASSURANCE

- A. All piping, fittings, valves and other components installed within a potable water distribution system shall comply with NSF 61 "Drinking Water System Components-Health Effects."
- B. In the State of Maryland, all piping, fittings, valves and other components installed within potable water system intended for human consumption shall comply with NSF 61 Annex G "Drinking Water System Components-Lead Content" or NSF 372 "Drinking Water System Components-Lead Content." Lead content shall comply with regulation .03 under COMAR 09.20.01 State Plumbing Code.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

- A. Lavatory P-2: Vitreous china, wall mounted, with self-draining area with contoured back and side shields .
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard model Lucerne
 - b. Kohler Co.
 - c. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - d. Sloan.
 - e. Toto
 - 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For wall hanging with concealed arms.

- c. Nominal Size: 19 by 16 inches.
 - d. Faucet-Hole Punching: One hole.
 - e. Faucet-Hole Location: Top ledge.
 - f. Color: White.
 - g. Mounting Material: Chair carrier.
- 3. Faucet: Specified herein.
 - 4. Support: Specified herein.

2.2 SOLID-BRASS, SENSOR OPERATED LAVATORY FAUCETS

- A. Lavatory Faucets P-2 & P-2A: Sensor-type, hard-wired, electronic-sensor-operated, nonmixing, solid-brass valve.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradley Corporation.
 - b. Chicago Faucets.
 - c. Moen Commercial.
 - d. Sloan Valve Company.
 - e. Speakman Company.
 - f. TOTO USA, INC.
 - g. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - 2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
 - 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.
 - 4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 - 5. Body Type: Single hole.
 - 6. Body Material: Commercial, solid brass.
 - 7. Finish: Polished chrome plate.
 - 8. Maximum Flow Rate: 0.5 gpm.
 - 9. Mounting Type: Back/wall, concealed.
 - 10. Spout: Rigid type.
 - 11. Spout Outlet: Spray.
 - 12. Drain: Not part of faucet.
 - 13. Accessible.
 - 14. Transformer: Required.

2.3 SUPPLY FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. McGuire Manufacturing Co. Model #**LF-167 LK = 3/8" x 1/2.**
 - 2. Engineered Brass Company.
 - 3. Brasscraft.
 - 4. Chicago.
- B. Standard: ASME A112.18.1/CSA B125.1.

- C. Supply Piping: Lead-free 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: Lead-free 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. Lead-free chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces riser.

2.4 WASTE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. McGuire Manufacturing Co. #C8912.
 - 2. Chicago.
 - 3. Engineered Brass Company.
 - 4. Brasscraft.
- B. Standard: ASME A112.18.2/CSA B125.2.
- C. Drain: Grid type with NPS 1-1/4 straight tailpiece.
- D. 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.

2.5 FIXTURE SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Josam Series 17100.
 - 2. Smith, Jay R.
 - 3. Zurn.
 - 4. Watts.
- B. Lavatory Supports, P-2.
 - 1. Description: ASME A112.6.1M, Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include rectangular steel uprights with feet.
 - 2. Accessible-Fixture Support: Include rectangular steel uprights.

2.6 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers, P-2 & P-2A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGuire Manufacturing Co.
 - b. Engineered Brass Company.
 - c. Plumberex.
 - d. Truebro; a brand of IPS Corporation.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.7 THERMOSTATIC MIXING VALVES

- A. Thermostatic Mixing Valve (HWMV-2): ASSE 1070 Certified, lead-free solid bronze construction with advanced thermal actuator for low flow performance (0.5 GPM), adjustable temperature selection with lock-down capabilities, union connections for easy maintenance and with integral check-stops and screens for preventing cross-flow and contamination.
 1. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
 - a. Powers Model LFLM495
 - b. Lawler
 - c. Symmons.
 - d. Leonard Valve Co.
 - e. Acorn.
 2. Where indicated on the drawings and required, mixing valves shall be provided within recessed cabinets with flange. Cabinets shall be stainless steel with hinged lockable door. Cabinets shall be provided with inlet/outlet knock-out holes for mounting flexibility.

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 lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install lavatories level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.

- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 23 0500 "Common Work Results for Mechanical."
- E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 9200 "Joint Sealants."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories.

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 1116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 1316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 4216.13

SECTION 22 4216.16

COMMERCIAL SINKS

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. Mop receptors.
2. Stainless steel sinks.
3. Sink faucets.
4. Supply fittings.
5. Waste fittings.
6. Fixture supports.

B. Related Requirements:

1. Section 22 1116 "Domestic Water Piping" for water supply connections to sinks.
2. Section 22 1316 "Sanitary Waste and Vent Piping" for sanitary waste and vent connections to sinks.

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 sinks.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. LEED Submittals:

1. Product Data for Prerequisite WE 1, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
2. Product Data for Prerequisite WE 1: Documentation indicating flow and water consumption requirements.
3. Product Data for Prerequisite WE 1 and Credit WE 2: Documentation indicating flow and water consumption requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sinks 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. Faucet Washers and O-Rings: One of each type and size installed.
 - 2. Faucet Cartridges and O-Rings: One of each type and size installed.

1.6 QUALITY ASSURANCE

- A. All piping, fittings, valves and other components installed within a potable water distribution system shall comply with NSF 61 "Drinking Water System Components-Health Effects."
- B. In the State of Maryland, all piping, fittings, valves and other components installed within a potable water system intended for human consumption shall comply with NSF 61 Annex G "Drinking Water System Components-Lead Content" or NSF 372 "Drinking Water System Components-Lead Content." Lead content shall comply with regulation .03 under COMAR 09.20.01 State Plumbing Code.

PART 2 - PRODUCTS

2.1 MOP RECEPTORS

- A. Mop Receptors P-8: Terrazzo, floor mounted.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. Crane Plumbing, L.L.C.
 - c. Florestone Products Co., Inc.
 - d. Stern-Williams Co., Inc.
 - 2. Fixture:
 - a. Standard: IAPMO PS 99.
 - b. Shape: Five sided.
 - c. Nominal Size: 24 by 24 inches.
 - d. Height: 12 inches with dropped front.
 - e. Tiling Flange: On two sides.
 - f. Rim Guard: On front top surfaces.
 - g. Color: Not applicable.
 - h. Drain: Grid with NPS 3 outlet.
 - 3. Mounting: On floor and flush to wall.
 - 4. Faucet: Specified herein.

2.2 STAINLESS STEEL SINKS

- A. Kitchenette Sink P-6: Stainless steel, counter mounted, double compartment, accessible.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Tabco.
 - b. Elkay Manufacturing Co.
 - c. Just Manufacturing.
 - d. Amtekco Industries, Inc.
2. Fixture:
 - a. Standard: ASME A112.19.3/CSA B45.4.
 - b. Type: Ledge back.
 - c. Number of Compartments: One.
 - d. Overall Dimensions: <Insert dimensions>.
 - e. Material: Seamless die-drawn construction of 18 gauge, type 304, 18-8 stainless steel. Interior surfaces shall be polished to a non-porous finish, with fully coated underside.
 - f. Each Compartment:
 - 1) Dimensions: <Insert dimensions>.
 - 2) Drains: Grid with NPS 1-1/2 tailpiece and twist drain.
 - 3) Drain Location: Centered in compartment.
3. Faucet(s): Specified herein.
 - a. Number Required: One.
 - b. Mounting: On ledge.
4. Supply Fittings: Specified herein.
5. Waste Fittings: Specified herein.
6. Mounting: On counter with sealant.

2.3 SINK FAUCETS

- A. Sink Faucets P-6: Manual type, two-lever-handle mixing valve.
 1. Commercial, Solid-Brass Faucets.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Chicago Faucets.
 - 2) Moen Commercial.
 - 3) Speakman Company.
 - 4) Zurn Plumbing Products Group.
 - 5) Sloan.
 2. Standard: ASME A112.18.1/CSA B125.1.
 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
 4. Body Type: Widespread.
 5. Body Material: Commercial, solid brass, lead-free.
 6. Finish: Polished chrome plate.
 7. Maximum Flow Rate: 1.5 gpm.
 8. Handle(s): Wrist blade, 4 inches.
 9. Mounting Type: Deck, concealed.
 10. Spout Type: Swivel gooseneck.

11. Vacuum Breaker: Not required.
- A. Sink Faucets, P-8: Manual type, two-lever-handle mixing valve, commercial, solid-brass faucets.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - a. Speakman Model SEF-9000-TW.
 - b. Chicago Faucets.
 - c. Moen Commercial.
 - d. Zurn Plumbing Products Group.
 - e. Sloan.
 2. Description: Barrier free, Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout with integral vacuum breaker and hose thread outlets and fixture receptor. Faucet shall include emergency eye wash feature with integral mixing valve to deliver ANSI Z358.1 tepid water.
 - a. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
 - b. Body Material: Cast brass.
 - c. Finish: Polished chrome plate.
 - d. Type: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, emergency eye wash, and pail hook.
 - e. Mixing Valve: Two-lever handle.
 - 1) Centers: 8 inches.
 - 2) Mounting: On wall, exposed.
 - f. Handles: Lever.
 - g. Inlets: NPS ½ female shank.
 - h. Spout: Rigid, cast with wall brace.
 - i. Spout Outlet: Hose thread.
 - j. Vacuum Breaker: Required.
 - k. Operation: Noncompression, manual.
 - l. Eyewash: ANSI Z358.1 certified.
 - m. Thermostatic mixing valve: ASSE 1071 Certified internal cold-water by pass system to ensure flow in the event of valve failure or loss of hot water supply. Supply valve also includes temperature/pressure gauge for diagnostics. The valve shall provide precise temperature control over a wide range of flow conditions, and effectively shut down on loss of cold water. The valve shall feature liquid filled thermostatic motor. and checkstops to prevent cross flow. The valve shall be factory set to 85°F with a lockable mean of securing the temperature

2.4 SUPPLY FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. McGuire Manufacturing Co., Model #LF2167LK = 1/2" x 1/2".
 2. Chicago.
 3. Engineered Brass Co.
 4. Brasscraft.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Lead-free 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: Lead-free 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. Lead-free chrome-plated, rigid-copper pipe.

2.5 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. McGuire Manufacturing Co.
 - 2. Chicago.
 - 3. Engineered Brass Co.
 - 4. Brasscraft.
- C. Drain: Grid type with NPS 1-1/2 straight tailpiece.
- D. Trap:
 - 1. Size: NPS 1-1/2.
 - 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.

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 sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- D. Set floor-mounted sinks in leveling bed of cement grout.

- E. Install water-supply piping with stop on each supply to each sink faucet.
 - 1. Exception: Use ball, gate, or globe valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 23 0519 "General-Duty Valves for Mechanical Piping."
 - 2. Install stops in locations where they can be easily reached for operation.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 23 0500 "Common Work Results for Mechanical."
- G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 9200 "Joint Sealants."
- H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 23 0700 "Mechanical Insulation."

3.3 CONNECTIONS

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 1116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 1316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 4216.16

SECTION 23 0130.51

HVAC AIR-DISTRIBUTION SYSTEM CLEANING

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 cleaning HVAC air-distribution equipment, ducts, plenums, and system components.
- B. Related Sections include the following:
 - 1. Commissioning of equipment or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Commissioning Authority. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure.
 - a. Refer to Section 01 7700 "Closeout Procedures" for substantial completion details.
 - b. Refer to Section 01 9113 "General Commissioning Requirements," Section 23 0800 "Commissioning of Mechanical Systems," and Section 26 0800 "Electrical System Commissioning" for detailed commissioning requirements.
 - c. Refer to Section 01 7820 "Operation and Maintenance Data" for operations and maintenance data requirements.

1.3 DEFINITIONS

- A. ASCS: Air systems cleaning specialist.
- B. NADCA: National Air Duct Cleaners Association.

1.4 SUBMITTALS

- A. Qualification Data: For an ASCS.
- B. Strategies and procedures plan.
- C. Cleanliness verification report.

1.5 QUALITY ASSURANCE

- A. ASCS Qualifications: A certified member of NADCA.
 - 1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
 - 2. Supervisor Qualifications: Certified as an ASCS by NADCA.
- B. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.

- C. Cleaning Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to HVAC air-distribution system cleaning including, but not limited to, review of the cleaning strategies and procedures plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.
- B. Perform "Project Evaluation and Recommendation" according to NADCA ACR 2006.
- C. Prepare written report listing conditions detrimental to performance of the Work.
- D. Proceed with work only after unsatisfactory conditions have been corrected.
- E. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Section 01 9113 "General Commissioning Requirements," Section 23 0800 "Commissioning of Mechanical Systems," and Section 26 0800 "Electrical Systems Commissioning" for further details.

3.2 PREPARATION

- A. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:
 - 1. Supervisor contact information.
 - 2. Work schedule including location, times, and impact on occupied areas.
 - 3. Methods and materials planned for each HVAC component type.
 - 4. Required support from other trades.
 - 5. Equipment and material storage requirements.
 - 6. Exhaust equipment setup locations.

- B. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.

- C. Comply with NADCA ACR 2006, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

3.3 CLEANING

- A. Comply with NADCA ACR 2006.

- B. Remove visible surface contaminants and deposits from within the HVAC system.

- C. Systems and Components to Be Cleaned: If SMACNA's "Duct Cleanliness for New Construction" specified cleanliness level is not achieved, clean all new duct systems; refer to Section 23 3113 "Metal Ducts."

- 1. Air devices for supply, return and exhaust air.
- 2. Air-terminal units.

3. Ductwork:
 - a. Supply-air ducts, including turning vanes and reheat coils, to the air-handling unit or fan-coil unit.
 - b. Return-air ducts to the fan-coil unit.
 - c. Exhaust-air ducts.
 4. Air-Handling Units:
 - a. Interior surfaces of the unit casing.
 - b. Coil surfaces compartment.
 - c. Condensate drain pans.
 - d. Fans, fan blades, and fan housings.
 5. Filters and filter housings.
- D. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.
- E. Particulate Collection:
 1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
 2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,
- F. Control odors and mist vapors during the cleaning and restoration process.
- G. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.
- H. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.
- I. Clean all air-distribution devices, registers, grilles, and diffusers.
- J. Clean visible surface contamination deposits according to NADCA ACR 2006 and the following:
 1. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
 2. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
 3. Clean evaporator coils, reheat coils, and other airstream components.
- K. Duct Systems:
 1. Create service openings in the HVAC system as necessary to accommodate cleaning.
 2. Mechanically clean duct systems specified to remove all visible contaminants so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
- L. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.
- M. Mechanical Cleaning Methodology:

1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.
 - a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
 - b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.
 2. Cleaning Mineral-Fiber Insulation Components:
 - a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR 2006.
 - b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
 - c. Fibrous materials that become wet shall be discarded and replaced.
- N. Coil Cleaning:
1. Measure static-pressure differential across each coil.
 2. See NADCA ACR 2006, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing Coil Cleaning Verification (see applicable NADCA ACR 2006).
 3. Coil drain pans shall be subject to NADCA ACR 2006, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
 4. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
 5. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations when available.
 6. Rinse thoroughly with clean water to remove any latent residues.
- O. Antimicrobial Agents and Coatings:
1. Apply antimicrobial agents and coatings if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
 2. When used, antimicrobial treatments and coatings shall be applied after the system is rendered clean.
 3. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.
 4. Sanitizing agent products shall be registered by the EPA as specifically intended for use in HVAC systems and ductwork.
- 3.4 CLEANLINESS VERIFICATION
- A. Verify cleanliness according to NADCA ACR 2006, "Verification of HVAC System Cleanliness" Section.

- B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocide agents and coatings.
- C. Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.
- D. Verification of Coil Cleaning:
 - 1. Measure static-pressure differential across each coil.
 - 2. Coil will be considered clean if cleaning restored the coil static-pressure differential within 10 percent of 1.0 inches w.g., the differential measured when the coil was first installed.
- E. Prepare a written cleanliness verification report. At a minimum, include the following:
 - 1. Written documentation of the success of the cleaning.
 - 2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
 - 3. Surface comparison test results if required.
 - 4. Gravimetric analysis (nonporous surfaces only).
 - 5. System areas found to be damaged.

END OF SECTION

SECTION 23 0500

COMMON WORK RESULTS FOR MECHANICAL

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. Refer to Division 22 Specifications Sections for equipment and materials related to Plumbing.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Coordination drawings.
 - 2. Piping materials and installation instructions common to most piping systems.
 - 3. Piping flexible connectors.
 - 4. Dielectric fittings.
 - 5. Mechanical sleeve seals.
 - 6. Sleeves.
 - 7. Escutcheons.
 - 8. Drives for machinery.
 - 9. Motor starting equipment.
 - 10. Drip pans.
 - 11. Grout.
 - 12. Packing material for penetrations.
 - 13. Equipment installation requirements common to equipment sections.
 - 14. Painting and finishing.
 - 15. Concrete bases.
 - 16. Supports and anchorages.
 - 17. Inspection of pressure vessels.
 - 18. Accessibility.
 - 19. Rigging of equipment.
 - 20. Flashing.
 - 21. Commissioning.
- B. Related Sections include the following:
 - 1. Section 01 7419 "Construction Waste Management and Disposal" for waste management requirements.
 - 2. Section 01 8113 "Sustainable Design Requirements- LEED" for additional requirements related to the LEED certification process.
 - 3. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - a. Section 01 9113 "General Commissioning Requirements".

1.3 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, mechanical and electrical equipment rooms, air handling unit service corridors, and accessible shafts.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations and at grade locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. Conditioned Space: Finished spaces and exposed interior spaces that are air conditioned. Examples include offices, corridors, etc., that are served by air conditioning equipment. Return-air plenums are not conditioned space.
- G. Return-air Plenums: Space between ceiling and structure above when return air is transferred from space to ceiling plenum in lieu of directly ducting return air from the space.
- H. Provide: Furnish and install.
- I. Directed: Directed by the Construction Manager.
- J. Indicated: Indicated by the Contract Documents.
- K. K-Factor: Number of British thermal units of heat transmitted per square foot per degree Fahrenheit temperature difference through a material with flat, parallel sides one inch apart.
- L. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Piping flexible connectors.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Escutcheons.
- B. Welding certificates.
- C. Certificates of Compliance for pressure vessels.

- D. Samples, drawings, specifications, catalogs, etc., submitted for approval shall be properly labeled indicating specific service for which material or equipment is to be used.
- E. Submit access door locations to the Architect for approval. Equipment requiring access doors shall not be installed prior to approval of access door locations.
- F. For systems included in the Commissioning Program provide one additional copy of the submittal for the Commissioning Agent.
- G. Coordination Drawings:
 - 1. Provide coordination drawings in accordance with Section 01 3100 "Project Management and Coordination". Provide coordination drawings detailing the work in the entire project.
 - 2. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components (i.e. electrical, plumbing, sprinkler, structural and architectural work). Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
 - a. Planned piping layout, including valve and specialty locations and valve-stem movement.
 - b. Clearances for installing and maintaining insulation.
 - c. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 - d. Equipment and accessory service connections and support details.
 - e. Fire-rated wall and floor penetrations.
 - f. Sizes and location of required concrete pads and bases.
 - g. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 - h. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 - i. See Section 23 3113 "Metal Ducts" for ductwork installation drawing requirements.
 - j. Reflected Ceiling Plans:
 - 1) Ceiling suspension assembly members.
 - 2) Other systems installed in same space as ducts.
 - 3) Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
 - 4) Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5) Refer to architectural ceiling plans for additional requirements.
 - k. Access Door Locations: Equipment requiring access doors shall not be installed prior to approval of access door locations.
 - l. Building Information Modeling: Utilize for preparing coordination drawings. Submit hard copy color views of representative sections and plans, and submit electronic file of the model in Revit or Navisworks.
- H. Qualification Data: for Installer.
- I. Field quality-control test reports.
- J. Operation and Maintenance Data:
 - 1. Operation and maintenance manuals and record product data as specified in Section 01 7823 "Operation and Maintenance Data".

2. Bound sets of approved submittals for items utilized on the project. Manufacturers' advertising literature or catalogs will not be acceptable for operating and maintenance instructions.

K. Record Documents:

1. See Section 01 7200 "Project Record Documents" for general requirements.
2. Carefully record the actual locations of each piece of pipe, valves, and other items.

L. LEED Submittals:

1. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, demonstrating compliance with low-emitting materials requirements.
2. Credit EQ 4.2: Manufacturers' product data for paints and coatings, demonstrating compliance with low-emitting materials requirements.
3. Credit EQ 4.4: For plywood backer boards installed within the building water proofing envelope, provide documentation indicating no added urea formaldehyde resins.
4. Credit EQ 3 & EQ 5: For filter media installed during construction and prior to occupancy, provide documentation indicating MERV rating.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. Any additional cost will not be reimbursed by the Owner. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- D. Give necessary notices and obtain required permits. Pay fees and other costs, including utility connections or extensions in connection with the work. File necessary plans, prepare documents and obtain necessary approvals of governmental agencies having jurisdiction. Obtain required certificates of inspection and deliver same to the Architect before request for acceptance and final payment for the work.
- E. Materials furnished and work installed shall comply with the latest issue of the codes, rules, regulations, and recommendations.
- F. Installer Qualifications:
 1. Mechanical contractors shall be a Maryland-licensed HVACR Master or Master Restricted contractor who is qualified in the areas of work included in the Project.
 2. The successful contractor shall agree to employ, in skilled positions, only individuals who hold valid licenses issued by the State HVACR Board of the Department of Labor, Licensing and Regulation to provide, or assist in providing, heating ventilating, air conditioning, or refrigerating system installation or service required for the project.

3. If the successful contractor subcontracts any or all of the heating, ventilating, air conditioning, or refrigerating system installation or service required for a project, the subcontractor must possess the appropriate license required and issued by the State HVACR Board.
4. All heating, ventilating, air conditioning, and refrigerating system subcontractors shall consistently use only individuals who hold the appropriate licenses issued by the State HVACR Board to provide or assist in providing heating, ventilating, air conditioning, and refrigerating system installation or service required for a project.
5. HVAC Refrigeration work to be performed following licensing requirements of Federal EPA Certified Refrigeration Mechanics.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 6000 "Product Requirements" for general requirements.
- 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 plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- D. Proper and suitable tools, equipment and appliances for the safe and convenient handling and placing of materials and equipment shall be used. During loading, unloading, and placing, care shall be taken in handling the equipment and materials so that no equipment or materials, including Owner furnished, are damaged.
- E. Mechanical equipment delivered to the job site shall be stored under roof or other approved covering, on pedestals above the ground. Enclosures for equipment shall be weatherproof.
 1. Any motors involved in the work that are not totally enclosed and electrical/electronic components shall be stored in a heated area with a minimum temperature of 50 deg. F.
 2. Valves shall be stored under roof on wood pedestals above ground. Pipe for project use shall be stored above grade and in such a manner to prevent entrance of foreign materials.
 3. Pipe shall be fitted with end caps or seals to prevent moisture and debris from entering pipe.
 4. Insulation shall be stored under roof or in trailers, adequately protected from the weather.
 5. Follow written instructions and recommendations of the manufacturer and requirements of the Architect in lubrication, protection and maintenance of equipment during storage.
- F. If materials or equipment are found to be in poor condition at the time of being installed, the Architect may, at his discretion, order the Contractor to furnish and install new equipment or materials at no cost to the Owner.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

- C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Section 08 3113 "Access Doors and Frames."

1.8 EQUIPMENT START-UP AND INITIAL OPERATION

- A. See Section 01 9113 "General Commissioning Requirements."
- B. No equipment shall be operated for testing or trial use until there has been full compliance with the equipment manufacturers' specifications and instructions for lubrication, alignment, direction of rotation, balance, and other applicable considerations.
- C. Particular care shall be taken to verify that equipment is completely assembled and properly lubricated, and grease and oil cases and reservoirs have been filled to the correct level with the recommended lubricant.
- D. Where specified, provide services of the manufacturer or his authorized representative to witness, supervise, or assist in the installation and start-up of equipment provided under this Division.

1.9 WARRANTY

- A. See Section 01 6000 "Product Requirements" for general requirements.
- B. Provide service of the equipment manufacturer or his authorized representative where required in other specification sections.

1.10 DRAWINGS

- A. The contract drawings are diagrammatic and indicate the general arrangements of systems and work included in the Contract. Do not scale the drawings. Consult the architectural and structural drawings and details for exact location of structure and equipment; where same are not precisely located, obtain this information prior to start of work.
- B. Layout of equipment indicated on drawings shall be checked and compared against drawings of trades, and exact locations and clearances for servicing determined using approved shop drawings of such equipment. Where the equipment furnished differs in physical character from that specified or indicated or where physical interference occurs, consult with Architect as to proper location of equipment. Prepare and submit for approval dated and dimensioned drawings correcting such interference's.
- C. Although the location of materials and equipment may be shown on the drawings in a certain place, the construction may develop conditions that render this location inaccessible or impractical. In such cases, before fabricating and installing the work, the Contractor shall call the condition to the attention of the Architect for direction. When requested by the Architect a detailed drawing of the proposed departure due to field conditions, or their causes, shall be submitted by the Contractor for approval. The Architect shall make final written decisions as to the conditions, which require the changing of work.

1.11 RECORD DRAWINGS

- A. See Section 01 7200 "Project Record Documents" and Section 01 7700 "Closeout Procedures" for general requirements.
- B. Carefully record the actual locations of each piece of concealed equipment, control devices, pipe, valves, ducts, terminal units, etc., including dimensions to locate underground work, and work when different from the contract drawings.

1.12 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. See Section 01 7700 "Closeout Procedures" and Section 01 7350 "Demonstration and Training" for general requirements of demonstration and training.
- B. Upon completion of work and of tests, furnish the necessary skilled labor and helpers for operating and demonstrating the systems and equipment.
- C. The instructor shall be thoroughly familiar with parts of the installation on which he is to give instruction and shall be trained in operating theory as well as practical operation and maintenance work. Employ factory trained instructors wherever necessary and as specified. Provide Owner with a DVD recording of the instruction sessions.
- D. Instructions shall include a general description of each system together with specific instructions describing routine and emergency procedures required of the building personnel for operating and maintaining each system. The instructions shall include the name or label, location, and function of operating equipment and controls. Operating modes and the procedures for indexing each mode shall be clearly described. Include lubrication charts and schedules of frequency of lubrication for equipment, designating each point of lubrication and type of lubricant to be used. Listings of names, addresses, and phone numbers of the service organizations for each item of equipment and a typewritten maintenance schedule for same shall be included.
- E. Provide operation and maintenance manuals and record product data as specified in Section 01 7200 "Project Record Documents."
 - 1. Submit Division 23 operation and maintenance manuals prior to substantial completion.

1.13 FIRE PROTECTION

- A. See Section 01 5000 "Temporary Facilities and Controls" for general requirements.
- B. As minimum, one five-pound CO₂ extinguisher shall be provided with each work crew.

1.14 SINGULAR NUMBER

- A. Where any device or part of equipment is herein referred to in the singular number, such as "valve", such reference applies to as many such devices as are required to complete the installation, shown, implied or otherwise, as indicated on the drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. General: All pipe, fittings and welding materials shall be manufactured in the United States of America.
- B. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- C. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. General:
1. Bolting of piping components shall be accomplished with bolts, nuts, and gaskets suitable for the service conditions to be encountered in accordance with proven industry standards. Notify Engineer prior to installation of work, if materials noted herein are at variance with above.
 2. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
 3. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. Gaskets for steam and condensate service shall be suitable for operating conditions of 250 to 366 degrees F at 150 psig. Gaskets shall be spiral-wound with a preformed Type 304 stainless steel strip and a filler material consisting of 99.9 percent carbon, with no binder, respirable fibers, lubricant or other additive, nominal thickness 0.175-inch, and 0.125-inch carbon steel outer ring. Gaskets shall be Flexitallic Model CG with flexicrab filler material or approved equal.
 2. Gaskets for water services shall be suitable for operating conditions of 40 to 180 degrees F at 150 psig. Gaskets shall have 1/16" thickness and be as manufactured by Thermoseal, Model KLINGER-sil C-6400 or approved equal.
 3. Flange gaskets for dielectric connections shall be one piece factory cut insulating gaskets between flanges and be constructed of ASTM D 229 electrical insulating material of 1000 ohms minimum resistance. Provide silicon-coated fiberglass insulating sleeves between the bolts and the holes in flanges; bolts may have reduced shanks of a diameter not less than the diameter at the root of threads. Provide 0.125 inch thick high-strength insulating washers next to flanges and provide stainless steel flat circular washers over insulating washers and under bolt heads and nuts. Provide bolts 0.5 inch longer than standard length to compensate for the thicker insulating gaskets and the washers under bolt heads and nuts.
 4. Flange Connections: Flange bolts and studs to conform to ASTM A 307, Grade B; and materials for nuts shall conform to ASTM A 194/A 194M, Grade 2. Dimensions of bolts,

studs, and nuts shall conform to ANSI B18.2.1 and ASME/ANSI B18.2.2 with threads conforming to ASME B1.1 coarse type, with Class 2A fit for bolts and studs, and Class 2B fit for nuts. Bolts or bolt-studs shall extend completely through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Carbon steel bolts shall have American Standard regular square or heavy hexagon heads and shall have American Standard heavy semifinished hexagonal nuts, conforming to ANSI B18.2.1 and ASME/ANSI B18.2.2.

- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 PIPING FLEXIBLE CONNECTORS

- A. Stainless-Steel Bellow, Flexible Connectors:
 - 1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
 - 2. End Connections: Threaded or flanged to match equipment connected.
 - 3. Performance: Capable of 3/4-inch misalignment.
 - 4. CWP Rating: 150 psig.
 - 5. Maximum Operating Temperature: 250 deg F.
- B. Rubber Flexible Connectors: ASTM F 1123, fabric-reinforced rubber with external control rods and complying with FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
 - 1. Manufacturers:
 - a. Flexicraft Industries.
 - b. Mason Industries, Inc.; Mercer Rubber Co.
 - c. Metraflex, Inc.
 - d. Vibration Mountings & Controls, Inc.
 - 2. Spherical Type: Single or multiple spheres (generally).
 - a. Minimum Pressure and Temperature Ratings for NPS 2 to NPS 12: 140 psig at 200 deg F.
 - 3. Material: EPDM.
 - 4. End Connections: Full-faced, integral, steel flanges with steel retaining rings.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials. Dielectric unions are not acceptable.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.

- C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150-psig minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.

- D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Separate companion flanges and steel bolts and nuts shall have 150-psig minimum working pressure where required to suit system pressures.

- E. Dielectric Waterway Fittings: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Manufacturers:
 - a. Victaulic Co. of America, Series 47

2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - e. Thunderline Linkseal.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Plastic. 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.

2.7 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.

2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.
- E. Split-Plate, Stamped-Steel Type: With concealed or exposed-rivet hinge, set screw, and chrome-plated finish.

2.9 DRIVES FOR MACHINERY

- A. Equip each motor driven machine with a V-belt drive except those that are directly connected. Factory designed and assembled belt drives that do not conform to the following will be rejected.
- B. Select each drive according to the rating and recommendation of the manufacturer (and as specified in other Sections) for the service with which used, giving proper allowance for sheave diameter, center distance, and arc of contact.
- C. Belts shall be constructed of endless reinforced cords of long staple cotton, nylon, rayon, or other suitable textile fibers imbedded in rubber. Use belts having correct cross section to fit properly in the sheave grooves. Carefully match belts for each drive.
- D. Unless otherwise specified, motor sheaves shall be adjustable pitch type so selected that the required fan rotation speed will be obtained with the motor sheave set approximately in mid-position and have the specified pitch diameter in that position.
 - 1. Motors driven by variable frequency controllers shall utilize fixed pitch type.
- E. Select the motor of a capacity needed to operate the equipment at the specified mid-position operating condition, and so that they have a nameplate rating of not less than 10 percent greater than the total of actual fan brake horsepower and drive loss at specified capacity. Where non-overloading of the motors is specified, select the motor capacity rating at closed position of the motor sheave. In no case shall motors be a smaller size than those scheduled.
- F. Do not select fan sheave smaller in diameter than 30 percent of the fan wheel diameter.
- G. Construct sheave of cast iron or steel, bored to fit properly on the shafts and secured with key ways of proper size, except that set screws may be used for sheaves having 1/2-inch or smaller bores.

- H. Provide OSHA approved guards for belt drives, with instrument openings at the fan and motor sheaves, constructed in accordance with SMACNA standards, ANSI B15.1, and OSHA 29 CFR 1910.219. Submit shop drawings for approval.

2.10 MOTOR STARTING EQUIPMENT

- A. Unless otherwise specified, motor control centers, starters, disconnect switches, combination starters and disconnect switches and variable frequency controllers shall be provided by the Division 26 Contractor, except for packaged equipment as specified under this Division.

2.11 DRIP PANS

- A. Where possible to run mechanical piping elsewhere, do not run mechanical piping directly above electrical (or electronic) work; otherwise provide drip pans under mechanical piping, sufficient to protect electrical work from drips. Locate pan immediately below piping, and extend a minimum of 6" on each side of piping and lengthwise 18" beyond the protected equipment. Fabricate pans of reinforced metal 2" deep, with rolled edges and soldered or welded seams; metal shall be 20 gage copper, or 18 gage steel with 2 oz. zinc finish hot dipped after fabrication. Provide 3/4" copper drainage piping, discharging to nearest floor drain, service sink, or as directed.

2.12 GROUT

- A. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
- B. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
 1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psi, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

2.13 PACKING MATERIAL FOR PENETRATIONS

- A. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
- B. Mineral fiber; non-combustible; resistant to water, mildew, and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 3.0 pounds per cubic foot.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21, 22 and 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements 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 by the Architect.

- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install manufactured, nonmetallic flexible pipe connectors according to Fluid Sealing Association's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors," and manufacturer's written instructions. Refer to Section 23 0548 "Mechanical Vibration Control" for additional requirements.
 - 1. Install piping and flexible connectors such that control rods do not short circuit the flexible connectors.
- M. Install escutcheons for exposed penetrations of walls, ceilings, and floors according to the following:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - 2. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - 3. Insulated Piping: One-piece, stamped-steel type with set screws.
 - 4. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - 5. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
- N. Unless indicated otherwise, sleeves are not required for core-drilled penetrations in solid concrete construction, except when located in floors of mechanical equipment areas. Seal annular space between pipe or pipe insulation and concrete as specified for sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other potential wet areas 4 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Unless indicated or specified otherwise, install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes penetrating concrete and masonry construction.
 - b. Steel Sheet Sleeves: For pipes penetrating gypsum-board or similar construction partitions and ceilings.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Section 07 6200 "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
 4. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint sealant for gypsum board assemblies.
 5. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.
 6. Install sleeves for pipes passing through walls, slabs, and ceilings of acoustic sensitive spaces in accordance with details of architectural drawings. Seal penetrations in accordance with details.
- P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Section 07 8413 "Penetration Firestopping" for materials.
- S. Verify final equipment locations for roughing-in.
- T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- U. Refer to installation details on drawings for additional requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. 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 unless dry seal threading is specified.
 - 2. 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.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 5. PVC Non-pressure Piping: Join according to ASTM D 2855.
 - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each control 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. Install dielectric flanges and waterway fittings to connect piping materials of dissimilar metals.

- B. Welded Fittings:
 - 1. Use fittings for changes in direction of piping and for connections.
 - 2. Reducing branch connections in steel piping may be made with forged branch outlet reducing fittings for branches two or more pipe sizes smaller than mains.
 - 3. Branch outlet fittings shall be forged, flared for improved flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength. Stub type connections will not be permitted.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations. In no case shall equipment be installed with service clearance less than manufacturer's recommendations.
- D. Install equipment to allow right of way for piping installed at required slope.
- E. Refer to installation details on drawings for additional requirements.

3.5 PAINTING

- A. Painting of mechanical systems, equipment, and components is specified in Section 09 9113 "Exterior Painting" And Section 09 9123 "Interior Painting".
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish. Provide complete new finish if, in the opinion of the Architect or Owner, the factory finishes are severely damaged.
- C. Miscellaneous requirements include:
 - 1. Touch up factory finishes and provide complete new finish if, in the opinion of the Architect or Owner, the factory finishes are severely damaged.
 - 2. Touch up threads of zinc coated screwed pipe with Rustoleum primer and one coat of enamel conforming to painting specification.
 - 3. Paint behind grilles and registers in finished areas with two coats of flat black paint following surface preparation of the zinc coated metal.
 - 4. Exposed hangers shall be field painted with Rustoleum primer and one coat of enamel conforming to painting specification.

3.6 CONCRETE BASES AND PADS FOR EQUIPMENT

- A. Concrete Bases and Pads: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 6 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. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Section 03 3000 "Cast-in-Place Concrete."
8. Refer to Section 23 0548 "Mechanical Vibration Control" for additional requirements.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 for structural steel.
- B. Provide supplemental structural members as required to adequately support piping and equipment.
- C. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- D. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF TEMPORARY WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.9 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.10 INSPECTION OF PRESSURE VESSELS

- A. For the purpose of obtaining and having the Owner's buildings insured by any commercial insurance carrier, the Contractor shall arrange for the inspection of pressure vessels installed during construction.
 - 1. Contractor shall obtain permits associated with the pressure vessels.
- B. The Contractor shall contact the Office of Boiler and Pressure Vessel Inspections of the Department of Labor, Licensing and Regulations (DLLR), State of Maryland, and arrange for the inspections.
- C. The DLLR shall be notified at least 30 days prior to installation.
- D. After such inspections are carried out by the State Inspector's office, Certificates of Compliance will be issued to the Contractor of record to be turned over to the Owner's representative for compliance with current insurance regulation as part of the Project Documents.
- E. Examples of pressure vessels include the heat exchangers, expansion tanks, air separators, water heaters, and water storage tanks.

3.11 WORKMANSHIP

- A. Furnish the services of an experienced full time field superintendent who shall be constantly in charge of the installation of the work provided under this Division. Superintendent shall have demonstrated experience with projects of comparable size and complexity and shall be approved by the Architect.
- B. The quality of workmanship required in the execution of the work shall be the finest and highest obtainable, working with the materials specified. Workmanship shall be satisfactory to the Architect and his decision as to acceptable quality is final.

3.12 EQUIPMENT CONNECTIONS

- A. Equipment shall be installed and connected in accordance with the best engineering practice and in accordance with manufacturer's instructions and recommendations. Auxiliary piping, valves, and electric connections recommended by the manufacturer or required for proper operation shall be provided.
- B. See Division 26 for electrical power wiring and final connections to motors and equipment requiring electric service. Temperature control wiring between starters and controlling devices and interlock wiring are specified in Section 23 0900 "Instrumentation and Control for HVAC". Verify that the proper power wiring services are installed prior to starting the equipment specified in Division 23.

3.13 CUTTING AND PATCHING

- A. See Section 01 7310 "Cutting and Patching" for general requirements.
- B. Cutting and patching of building materials shall be performed in a neat and workmanlike manner. Surfaces, which are damaged by the Contractor, shall be repaired or provided with new materials. Patching and materials shall be done with materials and methods similar to adjacent work, subject to approval of the Architect. Structural members shall not be cut or

penetrated unless indicated on the drawings and verified in the field with the Construction Manager. Holes cut through concrete and/or masonry to accommodate work under this Division shall be cut by reciprocating or rotary non-percussive methods.

3.14 SURVEYS AND MEASUREMENTS

- A. Base measurements, both horizontal and vertical, from established benchmarks. Work shall agree with these established lines and levels. Verify measurements at site and check correctness of same as related to the work.
- B. Should the Contractor discover any discrepancy between actual measurements or conditions, and those indicated which prevent following good practice or the intent of the drawings and specifications, he shall notify the Construction Manager and shall not proceed with his work until he has received instruction from the Construction Manager.

3.15 RIGGING OF EQUIPMENT

- A. Verify that rigging path for equipment prior to start of work or ordering of materials. Verify accessways and weight carrying capacity of building features, including elevators, floors, walls, ceilings, roofs, and related features. When equipment or sections of equipment are larger than available accessways, equipment shall be ordered in a knocked-down configuration for re-assembly at the site. Submit in writing to Architect where problems are encountered that may prohibit rigging of equipment into space with the proposed solutions.
- B. Use planking or cribbing as required to protect adjoining construction from damage. Protect equipment from damage until construction is completed.

3.16 WELDING

- A. Welding piping shall comply with the provisions of the latest revision of the ASME Code for Pressure Piping, ANSI/ASME B31.1 - Power Piping, and ANSI/ASME B31.9 - Building Services Piping. Contractor shall comply with requirements of federal, state or local agencies having legal jurisdiction that are more stringent than the above ANSI/ASME Codes.
- B. State, county, and city fire prevention code requirements, fire and safety regulations, and NFPA 241 shall be complied with, including the provision of appropriate portable fire extinguishers. Prior to performing welding within the building, notify the Construction Manager in advance of areas where welding will occur, and submit for approval a plan for protection of the building and occupants. Proceed only upon receipt of Construction Manager's approval and provide reasonable barriers, coverings, etc., as required or requested by the Construction Manager for protection of the installed work and building occupants. In regards to welding operations within the building, maintain a negative pressure within the work area to prevent the migration of smoke and fumes to occupied areas of the building. Provide temporary exhaust fans and smoke removal systems as required - discharge of smoke and fumes shall be to the building exterior in a manner to not be recirculated back into building through areaways, windows, etc. and away from public accessways.
- C. Provide single-vee type butt welds, unless specified otherwise. Joint configuration shall conform to ANSI B16.25.

- D. Before welding is performed, submit a copy of the Contractor's Standard Welding Procedure Specification together with the Procedure Qualification Record as required by Section IX of the ASME Boiler and Pressure Vessel Code.
- E. Before a welder shall perform welding, submit a copy of the Manufacturer's Record of Welder or Welding Operator Qualification Tests as required by Section IX of the ASME Boiler and Pressure Vessel Code.
- F. Welds shall have penetration complete to the inside diameter of the pipe and the recommended spacing and bevels between ends of pipe prior to welding shall be used to assure full penetration for high pressure steam piping. Weld penetrations for pipe service conditions other than high pressure steam piping shall be in accordance with the applicable ANSI/ASME Code.
- G. Visual and nondestructive examinations shall be performed to detect the surface and internal discontinuities in completed welds by an independent testing agency hired by the Construction Manager. The Contractor shall fully cooperate with an independent testing agency so that welds can be examined by the independent testing agency. The types and extent of non-destructive examinations required for pipe welds are as shown in Table 136.4 of ASME Code for Pressure Piping, ANSI/ASME B31.1-Power Piping and as contained herein. If requirements for visual and nondestructive examinations are to be other than contained herein, the degree of examination and basis of rejection shall be a matter of prior written agreement between the Construction Manager and the independent testing agency. The extent of visual and non-destructive examinations shall be as follows:
 - 1. The independent testing agency shall randomly select and test a minimum of 20% of the total length or number of piping welds by utilizing radiograph, ultrasonic testing, sectioning or a combination of these methods as determined by the independent testing agency. If a random weld test reveals that a weld fails to meet the minimum quality requirements, 100 percent of the welds in that same group shall be tested at the Contractor's expense and at no additional cost to the Owner. If the additional welds examined meet the quality requirements, the entire group of welds represented shall be accepted and the defective welds shall be repaired. If any of the additional welds examined also fail to meet the quality requirements as determined by the independent testing agency, that entire group of welds shall be rejected. Remove and re-weld rejected welds or examine rejected welds (at the Contractor's expense and at no additional cost to the Owner) and remove and re-weld defects.
 - 2. Welds shall be visually examined as follows:
 - a. Before welding -- for compliance with requirements for joint preparation, placement of backing rings or consumable inserts (if used), alignment and fit-up, and cleanliness.
 - b. During welding -- for conformance to the qualified welding procedure.
 - c. After welding -- for cracks, contour and finish, bead reinforcement, undercutting, overlap, and size of fillet welds.
 - 3. Welds determined to be unacceptable shall be removed and replaced by the Contractor, at no additional cost to the Owner, in accordance with the applicable standards. Repair defects discovered between weld passes before additional weld material is deposited. Wherever a defect is removed, and repair by welding is not required, the affected area shall be blended into the surrounding surface eliminating sharp notches, crevices, or corners. After defect removal is complete and before re-welding, re-examine the area by the same test methods that first revealed the defect to ensure that the defect has been eliminated. After re-welding, re-examine the repaired area by the same test methods originally used for that area. For repairs to base material, the minimum examination shall be the same as required for butt welds. Indication of a defect shall be regarded as a defect unless re-evaluation by non-destructive examination testing or by surface

conditioning shows that no unacceptable indications are present. The use of foreign material to mask, fill in, seal, or disguise welding defects will not be permitted.

- H. Pipe welds shall not be covered prior to examination by the independent testing agency. Should the independent testing agency encounter pipe joints that are covered, Contractor shall remove covering and replace with new covering, at no additional cost to the Owner, following examination by the independent testing agency. Coverings shall include, but not limited to, insulation, jacketing, outer conduit closure kits, special coatings, and backfill. Examinations of welds for the metal conduits for pre-insulated conduit piping systems may be covered without examination by the independent testing agency.
- I. Welding at hangers, supports and plates to structural members shall conform to American Welding Society, Inc. AWS D1.1 Structural Welding Code Steel.
- J. When requested by the independent testing agency or Architect, submit identifying stenciled test coupons made by any welder in question. The Contractor shall require a welder to retake the tests when, in the opinion of the Architect or independent testing agency, the work of the welder creates a reasonable doubt as to his proficiency. Tests, when required, shall be conducted at no additional expense to the Owner; and the welder in question shall not be permitted to work as a welder on this project until he has been re-qualified.
- K. The use of backing rings shall be at the discretion of the installing Contractor provided that the Contractor prepares and aligns pipes precisely to melt through to the inside surface - making a full penetration weld. At the direction of the independent testing agency, the Contractor may be directed to use backing rings (at no additional cost to the owner) when deemed necessary by the independent testing agency after examination of the pipe welds.
- L. When weld testing or examination is performed as required herein, the corresponding written certified test reports shall be submitted.

3.17 CLEANING

- A. See Section 01 7700 "Closeout Procedures."
- B. Thoroughly clean exposed surfaces of equipment and material and leave in a neat, clean condition ready for painting. Finished painting will be as specified in Section 09 9113 "Exterior Painting" and 09 9123 "Interior Painting".
- C. After completion of installation, thoroughly clean dirt, rust, loose scale, oils and grease, and other foreign matter for work.
- D. Clean all piping systems thoroughly of grease, metal shavings, welding beads or other refuse.
 - 1. Provide temporary piping as required to properly flush, clean, and dispose of water from site.
 - 2. Flush piping for minimum of 24 hours by use of portable pump or separate water supply to prevent damage to existing or new system pumps. Use cleaners and degreasers as specified in Section 23 2500.
 - 3. After flushing, clean strainers of debris. Refill and vent water systems being sure to add water to completely fill system after venting.
- E. Flush all systems with new potable water after pressure testing is complete and drain at low points. Continue flushing until water samples taken at all low points are clear of visible grease,

dirt, and contaminants. Obtain written acceptance from Owner upon completion of flushing acknowledging Owner's acceptance of system cleanliness.

- F. Clean all systems after flushing as follows:
1. Clean by flushing with water source to provide minimum 8 feet per second velocity until effluent is visibly as clean as the flushing medium.

3.18 PIPING SYSTEMS, GENERAL TESTING

- A. Piping systems shall be pressure tested hydrostatically in accordance with applicable codes. Testing shall be done in accordance with the following procedures:
1. Before testing, complete the installation of each pipe line, including supports, hangers and anchors. Perform testing before insulation is field-applied. Clean piping and equipment of metal cuttings and foreign matter as they are installed.
 2. Submit test procedures and schedules to the Engineer two weeks before testing starts. Test procedures and schedules shall be approved by the Engineer. All tests shall be witnessed and approved by the Owner or his designated representative.
 3. Codes - Pressure test piping to assure integrity of material and workmanship in accordance with the applicable ANSI/ASME Code for Pressure Piping B31, the Plumbing Code, or NFPA Standards as applicable.
 4. Pressure vessels, pumps, rotating and other mechanical equipment shall not be subject to the piping field pressure tests.
 5. Equipment, instruments and piping specialties which are not to be included in the test shall be either disconnected from the piping and the end of the pipe blanked off by a blind flange, plug or cap, or isolated.
 6. Test the piping in sections or circuits as required for the progress of the work.
 7. Systems to be pressurized shall be provided with appropriate gages and pressure-relieving devices.
 8. Test pressure readings may be taken at the lowest point in the line or system of lines, provided that the static head is added to the minimum test pressure.
 9. Lines containing check valves shall have the source of test pressure located on the high-pressure side of the valves. Line control valves shall be set and maintained in a wide-open position.
 10. The Owner may waive a pressure test for any reason. Such waiver shall be noted on the pressure test record.
 11. Duration of Test - Maintain the test pressure for a sufficient time but not less than 4 hours to determine and locate any leaks.
 12. Records - Provide a record of all tests. The record shall show line designation, test pressure, ambient temperature, date of test, retests, and signature of Owner's witness. If either testing or witnessing is waived, a note shall be made for each line so waived.
 13. Hydrostatic Test Procedures - Test the piping system hydrostatically in accordance with the requirements of the applicable ANSI/ASME Code for Pressure Piping B31.
 14. Repair of Line Leaks - Comply with the following procedures for repair of leaks. In each case, a retest shall be necessary after repairs are made and shall be made at no additional cost to the Owner.
 - a. Soldered/Brazed Joints - Remove solder/brazing alloy and reapply with proper flux.
 - b. Flanged End Joints - Check to determine flange end alignment and that all bolts are uniformly tightened with the required torque. If leak persists, depressurize the line, remove gasket, examine flange end faces, and insert new gasket.
 - c. Threaded Joints - Tighten joint to a reasonable torque. If leak does not stop, replace pipe and/or fittings. Do not use pipe dope or cement to stop pipe leaks.

- d. Gasketed Joints - Remove existing gasket and insert new gasket.
- e. Welded Joints - Replace joint.
- f. Leaks in Material - Leaks located in pipe material shall require the replacement of that section of pipe or fitting and repeat of the test from the beginning. Caulking, welding or epoxy is not permitted. Repair all damage caused by leaks. Repairs and retest shall be made at no additional cost to the Owner.

3.19 ACCESSIBILITY

- A. Locate equipment that must be serviced, operated or maintained, in fully accessible positions. Equipment shall include, but not be limited to, terminal units, coils, valves, motors, controllers, ATC dampers, drain points, cleanouts, etc. Provide adequate means to access equipment for repair and maintenance including capabilities for platforms, fall protection systems, and anchorage points.
- B. Where required or where directed, provide access doors. Locate equipment and associated access doors in accordance with the architectural reflected ceiling plan drawings (not all required access doors are indicated on the plans, only the ones that the Architect has specific requirements for placement). Doors installed in fire-rated walls or shafts shall be labeled and shall match rating of the construction. Doors shall be sufficient size to allow access to components, except minimum size shall be 12" x 16". Where equipment requires access to various parts, such as air terminal units require access to the controller and valve and piping appurtenances for the reheat coil, locate appurtenances requiring access such that all devices can be maintained from single door. For items that require access greater than 3 feet above the ceiling, provide minimum 4 feet x 4 feet removable ceiling panel to facilitate top of a folding ladder placed above the ceiling plane. Access doors are specified in Section 08 3113 "Access Doors and Frames."
- C. The Contractor at no expense to the Owner shall rework equipment deemed inaccessible by the Architect.
- D. Refer to Section 23 3300 "Air Duct Accessories" for access doors installed in ductwork.

3.20 FLASHING

- A. See Division 07 sections.
- B. Openings for pipes and ductwork through waterproofed roof areas shall be flashed.

3.21 COMMISSIONING

- A. Contractor shall be responsible for the installation verification and start-up of the mechanical equipment included in the Commissioning Program. Refer to Division 01 for details regarding the equipment and installation verification and start-up requirements for the Commissioning Program.
- B. Pre-functional performance testing: Contractor shall perform pre-functional performance testing prior to engaging Cx Agent and Owner for witnessing of functional performance testing.
- C. The functional performance testing of equipment included in the Commissioning Program shall be provided in accordance with Division 01 and Division 23 commissioning requirements. The

functional performance test shall include a demonstration by the installation contractor to verify that the equipment functions in accordance with the design intent.

- D. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
1. Section 01 9113 "General Commissioning Requirements".

END OF SECTION

SECTION 23 0513

COMMON MOTOR REQUIREMENTS FOR MECHANICAL 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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
- B. Related Sections include the following:
 - 1. Refer to Section 01 8113 "Sustainable Design Requirements" for additional requirements.
 - 2. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - a. Section 01 9113 "General Commissioning Requirements".

1.3 DEFINITIONS

- A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

1.4 SUBMITTALS

- A. Product Data: For each type and size of motor, provide nameplate data and ratings; shipping, installed, and operating weights; enclosure type and mounting arrangements; size, type, and location of winding terminations; conduit entry and ground lug locations; and information on coatings or finishes.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:
 - 1. Each installed unit's type and details.
 - 2. Nameplate legends.
 - 3. Diagrams of power, signal, and control wiring. Provide schematic wiring diagram for each type of motor and for each control scheme.
- C. For each motor or motor-driven equipment including at least the following:
 - 1. Unit or motor data defining efficiency and power factor at incremental loads (10% or smaller increments) from full load to no load without power factor correction.
 - 2. Maximum allowable power factor correction capacitance which will not cause over-excitation at no load.
 - 3. Data on each component used to achieve required power factor correction.
 - 4. Data to enable calculation of motor load at design duty.
 - 5. Value of Full Load Amperes (FLA) with correction capacitance provided and connected .

1.5 QUALITY ASSURANCE

- A. 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.
- B. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices and features that comply with the following:
 - 1. Motor controllers.
 - 2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
 - 3. Matched to torque and horsepower requirements of the load, including drive loss.
 - 4. Matched to ratings and characteristics of supply circuit and required control sequence.
- B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.
- C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MOTOR REQUIREMENTS

- A. Motor requirements apply to factory-installed motors except as follows:
 - 1. Different ratings, performance, or characteristics for motor are specified in another Section.
 - 2. Motorized-equipment manufacturer requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.
 - 3. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

- A. Motors 1/2 HP and Larger: Three phase.
- B. Motors Smaller Than 1/2 HP: Single phase.
- C. Frequency Rating: 60 Hz.
- D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
- E. Service Factor: 1.15 for open drip proof motors; 1.0 for totally enclosed motors.
- F. Duty: Continuous duty at ambient temperature of 122 deg F and at altitude of 3300 feet above sea level.

- G. 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.
- H. Enclosure: Open drip proof, unless indicated otherwise.
- I. Speed: 1750 RPM, unless indicated otherwise.
- J. Noise: Comply with maximum recommended IEC Standards (Tables B and C), and NEMA limits based on motor frame size, speed, and enclosure type, except maximum overall sound pressure levels shall not exceed 90 dBA as measured 3 feet from motor, and throughout its operating range from no load to full nameplate rating, and 15% speed to maximum speed to comply with CFR Title 41, Part 50-204.10.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium, as defined in NEMA MG 1.
- C. Stator: Copper windings, unless otherwise indicated.
- D. Rotor: Squirrel cage, unless otherwise indicated.
- E. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading.
- F. Temperature Rise: Match insulation rating, unless otherwise indicated.
- G. Insulation: Class F, unless otherwise indicated.
- H. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- I. Enclosure: Cast iron or rolled steel.
 - 1. Finish: Enamel.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Temperature Rise: Matched to rating for Class B insulation.
 - 3. Insulation: Class F.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

5. Shaft: Carbon steel.
6. Shaft Grounding: Provide shaft grounding brush equal to Aegis SGR™ Conductive Microfiber™ on drive end (between motor and shaft coupling to driven equipment).
7. Insulated Bearings: For 40 HP and larger, provide insulated type ceramic motor bearings on non drive end, opposite shaft grounded end.
8. Variable Frequency Controllers are specified in Section 23 2923 "Variable Frequency Motor Controllers."

- C. Source Quality Control for Field-Installed Motors: Perform the following tests on each motor according to NEMA MG 1:
1. Measure winding resistance.
 2. Read no-load current and speed at rated voltage and frequency.
 3. Measure locked rotor current at rated frequency.
 4. Perform high-potential test.

2.5 SINGLE-PHASE MOTORS

- A. Type: One of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
 2. Split-phase start, capacitor run.
 3. Capacitor start, capacitor run.
- B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.
- C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
- D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.

PART 3 - EXECUTION

3.1 COMMISSIONING

- A. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
1. Section 01 9113 "General Commissioning Requirements".

END OF SECTION

SECTION 23 0519

METERS AND GAGES FOR MECHANICAL 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. This Section includes the following meters and gages for mechanical systems:
 - 1. Thermometers.
 - 2. Gages.
 - 3. Test plugs.
- B. Related Sections include the following:
 - 1. Section 22 1116 "Domestic Water Piping" for domestic and make-up water service meters inside the building.
 - 2. Section 23 0900 "Instrumentation and Control for HVAC" for hydronic and steam service flow meters inside the building.
 - 3. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - a. Section 01 9113 "General Commissioning Requirements".

1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.
- B. Shop Drawings: Schedule for thermometers and gages indicating manufacturer's number, scale range, and location for each.
- C. Product Certificates: For each type of thermometer and gage signed by product manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles below where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 REMOTE-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

- A. Manufacturers:
 - 1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 - 2. Marsh Bellofram.
 - 3. Miljoco.
 - 4. Trerice, H. O. Co.
 - 5. Weiss Instruments, Inc.
 - 6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Case: Dry type, cast aluminum, 4-1/2-inch diameter with holes for panel mounting.
- C. Element: Silicone damped bourdon tube.
- D. Movement: Mechanical, connecting element and pointer.
- E. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
- F. Pointer: Red or other dark-color metal.
- G. Window: Glass.
- H. Ring: Aluminum.
- I. Connector: Bottom or back union type, to suit application.
- J. Thermal System: Gas/activated carbon filled bulb in copper-plated steel, aluminum, brass, or stainless steel stem for thermowell installation and of length to suit installation.
- K. Accuracy: Plus or minus 1 percent of full range.

2.3 DIRECT MOUNTING DIGITAL THERMOMETERS

- A. Manufacturers:
 - 1. Trerice, H. O. Co., SX9 Solar Therm
 - 2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 - 3. Marsh Bellofram.
 - 4. Miljoco.
 - 5. Trerice, H. O. Co.
 - 6. Weiss Instruments, Inc.
 - 7. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Description: Direct-mounting, light-powered digital thermometers.
- C. Case: Cast aluminum with cured epoxy coating, 7-inch.
- D. Display: 9/16" LCD display lights, switchable between Fahrenheit and Celsius, minimum and maximum readings with reset. Resolution 0.1 deg with full 4-digit display and an update interval of 10 seconds.
- E. Power Source: Minimum 10 Lux (one foot candle) ambient light source; no external power or batteries shall be required.

- F. Connector: Adjustable angle type.
- G. Stem: Metal, for thermowell installation and of length to suit installation.
- H. Accuracy: Plus or minus 1 percent of full range.

2.4 THERMOWELLS

- A. Manufacturers:
 - 1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 - 2. Marsh Bellofram.
 - 3. Miljoco.
 - 4. Terice, H. O. Co.
 - 5. Weiss Instruments, Inc.
 - 6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Manufacturers: Same as manufacturer of thermometer being used.
- C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.
 - 1. Extension Neck: For insulated piping.

2.5 PRESSURE GAGES

- A. Manufacturers:
 - 1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 - 2. Marsh Bellofram.
 - 3. Miljoco.
 - 4. Terice, H. O. Co.
 - 5. Weiss Instruments, Inc.
 - 6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
 - 1. Case: Dry- or Liquid-filled (as indicated) type, fiberglass reinforced polypropylene, solid front with blowout back, 4-1/2-inch diameter.
 - 2. Pressure-Element Assembly: Bronze or stainless steel bourdon tube, unless otherwise indicated.
 - 3. Pressure Connection: Brass or 316 stainless steel, NPS 1/4, bottom-outlet.
 - 4. Movement: Mechanical, with stainless steel link to pressure element and connection to pointer.
 - 5. Dial: White satin-faced, non-reflective aluminum with permanently etched scale markings.
 - 6. Pointer: Black or other dark-color metal.
 - 7. Window: Acrylic.
 - 8. Ring: Threaded fiberglass reinforced polypropylene.
 - 9. Accuracy: Grade 1A, plus or minus 1 percent of full range.
 - 10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
 - 11. Range for Fluids under Pressure: Two times operating pressure.

- C. Remote-Mounting, Dial-Type Pressure Gages: ASME B40.100, indicating-dial type.
1. Case: Dry- or Liquid-filled type (as indicated), fiberglass reinforced polypropylene, 4-1/2-inch diameter with holes for panel mounting.
 2. Pressure-Element Assembly: Bronze or stainless steel bourdon tube, unless otherwise indicated.
 3. Pressure Connection: Brass or 316 stainless steel, NPS 1/4, bottom-outlet or back-outlet type, connected for easy reading.
 4. Movement: Mechanical, with stainless steel link to pressure element and connection to pointer.
 5. Dial: White satin-faced, non-reflective aluminum with permanently etched scale markings.
 6. Pointer: Black or other dark-color metal.
 7. Window: Acrylic.
 8. Ring: Threaded fiberglass reinforced polypropylene.
 9. Accuracy: Grade 1A, plus or minus 0.5 percent of full half range.
 10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
 11. Range for Fluids under Pressure: Two times operating pressure.
- D. Pressure-Gage Fittings:
1. Valves: NPS 1/4 ball type.
 - a. General Service: Provide ball valve equal to ball shut-off valves specified for particular service in Section 23 0523 "General Duty Valves for Mechanical Piping."
 - b. Steam and Steam Condensate Service: NPS 1/4 carbon steel or stainless steel needle type; suitable for 300 psig and 450 deg F.
 2. Siphons: NPS 1/4 coil of schedule 80 welded steel or stainless steel tubing with socket welded ends; suitable for 300 psig and 450 deg F.
 3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.6 TEST PLUGS

- A. Manufacturers:
1. Flow Design, Inc.
 2. Peterson Equipment Co., Inc.
 3. Sisco Manufacturing Co.
 4. Trelice, H. O. Co.
 5. Watts Industries, Inc.; Water Products Div.
- B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.
- C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- D. Core Inserts: One or two self-sealing rubber valves.
1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
 2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.
- E. Test Kit: Furnish two test kits containing one pressure gage and adaptor, two thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.

2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
4. Carrying case shall have formed instrument padding.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

- A. Install remote-mounting, vapor-actuated dial thermometers where installed greater than 96 inches above floor.
- B. Install direct mounting digital type thermometers where installed within 96 inches above floor.
- C. Provide the following temperature ranges for thermometers, except digital type thermometers to have inherent range of -40 to 300 deg F:
 1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
 2. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.
 3. Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions.
 4. Domestic Hot Water and Tepid Water: 30 to 180 deg F, with 2-degree scale divisions.
 5. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.

3.2 GAGE APPLICATIONS

- A. Install direct-mounting type pressure gages where installed within 84 inches of floor.
- B. Install remote-mounting type pressure gages where installed greater than 84 inches above floor.
- C. Install liquid-filled case type, except for gages mounted outdoors. Install dry case type for gages mounted outdoors.
- D. Provide bronze pressure-element assembly and pressure connections for each pressure gage for fluids.
- E. Provide the following pressure ranges for gages:
 1. General: Normal pointer position in mid-span of gage range.
 2. Heating Hot Water: 0 to 200 psig, with 2-psi scale divisions.
 3. Chilled Water: 0 to 200 psig, with 2-psi scale divisions.
 4. Domestic Hot Water and Tepid Water: 0 to 200 psi, with 2-psi divisions
 5. Domestic Cold Water: 0 to 200 psig, with 2-psi scale divisions.
 6. Storm Water Pumped Discharge: 0 to 30 psi, with 1-psi scale divisions

3.3 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

- C. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees or threadolets where thermometers are indicated, and where required for ATC devices. Coordinate with Section 23 0900 "Instrumentation and Control for HVAC."
 - 1. Install heat conducting compound within thermowell.
 - D. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.
 - E. Install direct-mounting pressure gages in piping tees or threadolets with pressure gage located on pipe at most readable position.
 - 1. Install in weldolets for steam service.
 - F. Install remote-mounting pressure gages on panel.
 - G. Install ball-valve and snubber fitting in piping for each pressure gage for fluids (except steam); minimize length of piping nipples between gages and piping mains.
 - H. Install needle-valve, siphon fitting, and snubber fitting in piping for each pressure gage for steam.
 - I. Install test plugs in piping tees or threadolets.
- 3.4 CONNECTIONS
- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.
- 3.5 ADJUSTING
- A. Calibrate meters according to manufacturer's written instructions, after installation.
 - B. Adjust faces of meters and gages to proper angle for best visibility.
- 3.6 COMMISSIONING
- A. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - 1. Section 01 9113 "General Commissioning Requirements".

END OF SECTION

SECTION 23 0523

GENERAL DUTY VALVES FOR MECHANICAL PIPING

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 general-duty valves:
 - 1. Copper-alloy ball valves.
 - 2. Ferrous-alloy ball valves.
 - 3. Ferrous-alloy butterfly valves.
 - 4. Swing check valves - bronze.
 - 5. Spring-loaded, lift-disc check valves.
 - 6. Ferrous-alloy check valves.
 - 7. Cast-iron gate valves.
 - 8. Steel gate valves.
 - 9. Bronze globe valves.
 - 10. Cast-iron globe valves.
 - 11. Ferrous-alloy globe valves.
 - 12. Chainwheel actuators.
 - 13. Ductile iron ball valves.
- B. Related Sections include the following:
 - 1. Division 33 piping sections for general-duty and specialty valves for site construction piping.
 - 2. Division 21 fire-suppression systems sections for fire-protection valves.
 - 3. Section 23 0553 "Identification for Mechanical" for valve tags and charts.
 - 4. Section 23 0900 "Instrumentation and Control for HVAC" for control valves and actuators.
 - 5. Division 23 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS

- A. The following are standard abbreviations for valves:
 - 1. CWP: Cold working pressure.
 - 2. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 3. NBR: Acrylonitrile-butadiene rubber.
 - 4. OS&Y: Outside screw and yoke
 - 5. PTFE: Polytetrafluoroethylene plastic.
 - 6. RF: Raised face.
 - 7. SWP: Steam working pressure.
 - 8. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; actuators; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

- A. ASME Compliance: ASME B31.1 for power piping valves (steam and condensate piping systems) and ASME B31.9 for building services piping valves (remaining piping systems).
 - 1. Exceptions: Domestic hot- and cold-water piping valves unless referenced.
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 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, and weld ends.
 - 3. Set gate and globe valves closed to prevent rattling.
 - 4. Set ball valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- 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 handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles below where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Bronze Valves: Water Service - NPS 2 and smaller with threaded ends, unless otherwise indicated.

- C. Ferrous Valves: Water Service - NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.
 - D. Ferrous-Alloy, Steel Valves: NPS 2-1/2 and larger with welded ends, OS&Y type, ANSI Class as indicated, cast steel body, 13% Cr. stainless steel trim, bored to match inside diameter of pipe.
 - 1. Gate and globe valves with packing suitable for replacement under full rated working pressure of valve.
 - E. Ferrous-Alloy, Steel Valves: NPS 2 and smaller with welded ends, minimum ANSI Class as indicated, cast steel or forged carbon steel body, 13% Cr. stainless steel trim, bored to match inside diameter of pipe.
 - 1. Gate and globe valves with packing suitable for replacement under full rated working pressure of valve.
 - F. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
 - G. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
 - H. Valve Actuators:
 - 1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
 - 2. Gear Drive with Adjustable Memory Stop: For quarter-turn valves NPS 4 and larger, unless otherwise noted.
 - a. Steam Service: For quarter-turn valves NPS 2 and larger. For high performance butterfly valves for steam service, manual low reduction gear operators shall require a minimum of 20 turns from the "open" position to the "closed" position.
 - 3. Handwheel: For valves other than quarter-turn types. Valve hand wheels shall be cast.
 - 4. Lever Handle with Adjustable Memory Stop: For quarter-turn valves NPS 5 and smaller.
 - 5. Gear operators shall be packed with high temperature grease.
 - I. Extended Valve Stems: On insulated valves; minimum 2" extension.
 - J. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
 - K. Threaded: With threads according to ASME B1.20.1
 - L. Valve Bypass and Drain Connections: MSS SP-45.
 - M. Valve Manufacturer: Each valve type in same system shall be by a single manufacturer and same model.
 - N. Control Valves: Refer to Section 23 0900 "Instrumentation and Control for HVAC" for control valves and actuators.
- 2.3 COPPER-ALLOY BALL VALVES
- A. Manufacturers:
 - 1. Two-Piece, Copper-Alloy Ball Valves:
 - a. Conbraco Industries, Inc.; Apollo Div.
 - b. Crane Co.; Crane Valve Group; Crane Valves.

- c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Jamesbury, Inc.
 - e. Milwaukee Valve Company.
 - 2. Safety-Exhaust, Copper-Alloy Ball Valves:
 - a. Conbraco Industries, Inc.; Apollo Div.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Jamesbury, Inc.
 - e. Milwaukee Valve Company.
 - B. Copper-Alloy Ball Valves, General: MSS SP-110.
 - C. Two-Piece, Copper-Alloy Ball Valves: Bronze body with regular-port, solid stainless steel tunnel drilled ball; RPTFE 15% glass-filled seats; 25% glass-filled thrust washer; PTFE packing; brass hexagonal threaded packing nut; and 600-psig minimum CWP rating and blowout-proof stainless steel stem.
 - D. Safety-Exhaust, Copper-Alloy Ball Valves: Two-piece bronze body with exhaust vent opening, chrome-plated solid tunnel drilled brass ball with vent, blowout-proof brass stem, RPTFE seats, multiple piece "V" ring PTFE packing, PTFE thrust washer and body/tail piece seal, hexagonal threaded gland follower, stainless steel tamper-proof latch, lock lever handle, and working pressure rating of 600-psig WOG at 250°F.
- 2.4 FERROUS-ALLOY BALL VALVES
- A. Manufacturers:
 - 1. Conbraco Industries, Inc.; Apollo Div.
 - 2. Crane Co.; Crane Valve Group; Stockham Div.
 - 3. Jamesbury, Inc.
 - 4. Milwaukee Valve Company.
 - 5. Worcester.
 - B. Ferrous-Alloy Ball Valves, General: MSS SP-72.
 - C. Two-Piece, Ferrous-Alloy Ball Valves: Classes 150 and 300, standard port. ASTM A216 Grade WCB cast carbon steel body with threaded ends, 316 stainless steel standard port vented ball (vented from body cavity to tunnel of ball), stainless steel stem, reinforced Teflon seat and thrust washer, Teflon body seal, multiple piece V-ring or graphite stem packing, and threaded hexagonal gland follower. For drain valve applications, provide outlet with garden hose threads and cap.
- 2.5 FERROUS-ALLOY BUTTERFLY VALVES
- A. Manufacturers:
 - 1. Single-Flange, Ferrous-Alloy Butterfly Valves:
 - a. Bray International, Inc.
 - b. Grinnell Corporation.
 - c. Milwaukee Valve Company

- B. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, Type I, with zero leakage at up to 200 psig in either direction, dead-end service, with disc and lining suitable for potable water, unless otherwise indicated.
- C. Single-Flange, 150-psig CWP Rating, Ferrous-Alloy Butterfly Valves: ASTM A 126 cast iron or ASTM A 536 ductile iron body, lug type with through-tapped lugs; two-piece blowout proof stainless steel stem; phenolic backed cartridge with molded lip for dead-end service, field replaceable liner, EPDM elastomer seat suitable for 275F, stainless steel or aluminum bronze disc, and Buna N ring stem and dirt seals.
 - 1. For potable water applications, the stainless steel disc shall comply with either ASTM 312 or ASTM A 778.

2.6 SWING CHECK VALVES - BRONZE

- A. Manufacturers:
 - 1. Type 3, Bronze, Horizontal Swing Check Valves with Metal Disc:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Grinnell Corporation.
 - e. Milwaukee Valve Company
- B. Bronze Check Valves, General: MSS SP-80.
- C. Type 3, Class 125, Bronze, Horizontal Swing Check Valves: Bronze body with bronze disc, plug, and 5 degree integral seat; stainless steel retaining ring and hinge pin.

2.7 GRAY-IRON SWING CHECK VALVES

- A. Manufacturers:
 - 1. Type I, Gray-Iron Swing Check Valves with Metal Seats:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Grinnell Corporation.
 - e. Milwaukee Valve Company
- B. Gray-Iron Swing Check Valves, General: MSS SP-71.
- C. Type I, Class 125, gray-iron, swing check valves with metal seats.

2.8 SPRING-LOADED, LIFT-DISC CHECK VALVES

- A. Manufacturers:
 - 1. Horizontal Lift-Disc Check Valves:
 - a. Spirax-Sarco, Inc. or approved equal.
 - 2. Type III, Globe Lift-Disc Check Valves:
 - a. Grinnell Corporation.
 - b. Milwaukee Valve Company.
 - 3. Type IV, Threaded Lift-Disc Check Valves:
 - a. Grinnell Corporation.
 - b. Milwaukee Valve Company.

c. Mueller Steam Specialty.

- B. Lift-Disc Check Valves, General: FCI 74-1, with spring-loaded bronze or alloy disc and bronze or alloy seat.
- C. Type III, Class 125, Globe Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends; center-guided bronze plug, bushing, and seat ring; stainless steel seat ring and seat ring screws.
- D. Horizontal Lift-Disc Check Valves: Bronze body; brass cone and cap; stainless steel spring; suitable for 145 psig at 350 deg F; threaded ends.

2.9 FERROUS-ALLOY SWING CHECK VALVES

- A. Manufacturers:
 - 1. Cast Carbon Steel Swing Check Valves with Metal Seats:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Milwaukee Valve Company.
 - d. Mueller Steam Specialty.
- B. Cast Carbon Steel Swing Check Valves with Metal Seats: Class 150 horizontal swing check; cast carbon steel body, cover, disc support, disc, and disc hinge; hard-faced cobalt chrome welded in seat rings; 13 percent chrome material disc seat face; stainless steel hinge pin; and flanged ends.

2.10 STEEL GATE VALVES

- A. Manufacturers
 - 1. Steel Gate Valves:
 - a. Crane, Figure 33-1/2 (Class 300) / Figure 47-1/2 (Class 150).
 - b. Stockham.
- B. Ferrous-Alloy Gate Valves: ASME/ANSI B16.34, OS&Y rising stem; flexible wedge; bolted bonnet; cast-carbon steel body, bonnet, yoke, yoke cap, and wedge; hard-faced cobalt chrome welded in seat rings; 13 percent chrome material wedge seat face and stem; flexible graphite stem packing; graphite sealing rings; and flanged ends.

2.11 BRONZE GATE VALVES

- A. Manufacturers
 - 1. Type 2, Bronze, Rising-Stem, Solid-Wedge Gate Valves:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Grinnell Corporation.
 - e. Milwaukee Valve Company.
- B. Bronze Gate Valves, General: MSS SP-80, with ferrous-alloy handwheel.
- C. Type 2, Class 125, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge and union-ring bonnet.

2.12 CAST-IRON GATE VALVES

- A. Manufacturers
 - 1. Type I, Cast-Iron, Rising-Stem Gate Valves:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Grinnell Corporation.
 - e. Milwaukee Valve Company.
- B. Cast-Iron Gate Valves, General: MSS SP-70, Type I.
- C. Class 125, OS&Y, Bronze Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, rising stem, and solid wedge disc.

2.13 BRONZE GLOBE VALVES

- A. Manufacturers:
 - 1. Type 2, Bronze Globe Valves with Nonmetallic Disc:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Grinnell Corporation.
 - e. Milwaukee Valve Company.
- B. Bronze Globe Valves, General: MSS SP-80, with ferrous-alloy handwheel.
- C. Type 2, Class 150, Bronze Globe Valves: Bronze body with hexagon gland follower, rising stem, minimum four-sided stem to hand-wheel connection with self-locking nut, disc union-ring bonnet, integral seat; aramid fiber and graphite packing with a neoprene binder for service up to 550 deg F.

2.14 CAST-IRON GLOBE VALVES

- A. Manufacturers:
 - 1. Type I, Cast-Iron Globe Valves with Metal Seats:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Grinnell Corporation.
 - e. Milwaukee Valve Company.
- B. Cast-Iron Globe Valves, General: MSS SP-85.
- C. Type I, Class 125, Cast-Iron Globe Valves: Gray-iron body with hexagon gland follower, rising stem, bolted bonnet, brass stem and packing gland, minimum four-sided stem to hand-wheel connection with self-locking nut, bronze seats; aramid fiber and graphite packing with neoprene binder for service up to 550 deg F.

2.15 FERROUS-ALLOY GLOBE VALVES

- A. Manufacturers:

1. Ferrous-Alloy Class 150 and 300 Globe Valves with Metal Seats:
 - a. Crane Co.; Crane Valve Group; Stockham Div.
 - b. Stockham.

- B. Classes 150 and 300 Cast Steel Globe Valves: OS&Y; solid disc; bolted bonnet; cast steel body and bonnet; stainless steel trim; and welded ends.
 1. Where warm-up valves are indicated on the drawings, integral valve bypass connection and globe valves may be provided in accordance with MSS SP-45. Globe valves and connections shall be equal to those specified for given service.

2.16 CHAINWHEEL ACTUATORS

- A. Manufacturers:
 1. Babbitt Steam Specialty Co.
 2. Roto Hammer Industries, Inc.
- B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
 2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 3. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. 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.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. 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.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
 1. Shutoff Service: Ball, butterfly, or gate valves for water service.
 2. Throttling Service: Ball, butterfly, or globe valves for water service.
 3. Pump Discharge Check Valves: Spring-loaded, lift-disc check valves.
 4. Warm-up Service: Globe valves.

- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Chilled-Water Piping: Use the following types of valves:
 - 1. Ball Valves, NPS 2-1/2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
 - 2. Swing Check Valves, NPS 2-1/2 and Smaller: Type 3, Class 125, bronze.
 - 3. Globe Valves, NPS 2-1/2 and Smaller: Type 2, Class 150, bronze.
- D. Heating Hot Water Piping: Use the following types of valves:
 - 1. Ball Valves, NPS 2-1/2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
 - 2. Swing Check Valves, NPS 2-1/2 and Smaller: Type 3, Class 125, bronze.
 - 3. Globe Valves, NPS 2-1/2 and Smaller: Type 2, Class 150, bronze.
- E. Non-Potable and Domestic Water Piping: Use the following types of valves:
 - 1. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
 - 2. Butterfly Valves, NPS 2-1/2 and Larger: Single-flange, 150-psig CWP rating, ferrous alloy, with EPDM liner and stainless steel disc.
 - 3. Swing Check Valves, NPS 2 and Smaller: Type 3, Class 125, bronze.
 - 4. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type III, Class 125, cast iron.
 - 5. Globe Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
 - 6. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.
- F. Pumped Storm Drainage Piping: Use the following types of valves:
 - 1. Swing Check Valves, NPS 2 and Smaller: Type 3, Class 125, bronze.
 - 2. Swing Check Valves, NPS 2-1/2 and Larger: Type 1, Class 125, gray iron.
 - 3. Gate Valves NPS 2 and Smaller: Type 2, Class 150, bronze.
 - 4. Gate Valves, NPS 2-1/2 and Larger: Type 1, Class 125, OS&Y, bronze-mounted cast iron.
- G. Select valves, except wafer and flangeless types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for condenser water.
 - 2. For Copper Tubing, NPS 2-1/2 and larger: Flanged ends.
 - 3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 4. For Steel Piping, NPS 2-1/2 and larger: Flanged ends, except high pressure steam with welded ends.
 - 5. For Grooved-End, Steel Piping: Flanged ends.

3.3 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves in strict accordance with recognized industry standards, valve manufacturer's recommendations, and the general guidelines noted herein.
- C. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- D. Locate valves for easy access, smooth and easy actuator operation, and packing maintenance; provide separate support where necessary.

- E. When placing valves between welding type flanges, carefully position the valve between the flanges with the flange bores and valve body properly aligned. Span the valve body with the flange bolts and properly align the assembly with the pipe. Tack weld the flanges to the pipe. When tack welding is complete, remove the flange bolts and the valve from the pipe flanges prior to completing the welding of the pipe flanges. After completing the welding of the pipe flanges, let the pipe and flanges cool to ambient temperature, before installing the valve between the pipe flanges.
- F. When placing threaded bodied valves in pipelines, note the internal length of threads in the valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into the valve. Align threads at point of assembly. Apply appropriate thread sealants to the external pipe threads. Assemble joint, wrench tight with the wrench on the valve end (not valve body) into which the pipe is being threaded.
- G. Install valves in horizontal piping with stem at or above center of pipe.
- H. Install valves in position to allow full stem movement.
- I. Install butterfly valves between weld neck companion flanges of the same ANSI class as the valve.
- J. Install chainwheel operators on valves NPS 2-1/2 and larger and more than 96 inches above floor or grade. Extend chains to 60 inches above finished floor or grade elevation.
- K. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

- A. Refer to Section 23 0500 "Common Work Results for Mechanical" for basic piping joint construction.

3.5 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.

END OF SECTION

SECTION 23 0529

HANGERS AND SUPPORTS FOR MECHANICAL PIPING AND 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. This Section includes the following hangers and supports for mechanical system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Pipe positioning systems.
 - 8. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 05 Sections for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 22 Sections for plumbing materials and equipment.
 - 3. Section 23 0548 "Mechanical Vibration Control" for vibration isolation devices and additional hanger and support requirements.
 - 4. Section 23 3113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
 - 3. Powder-actuated fastener systems.
 - 4. Pipe positioning systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Pipe stands. Include Product Data for components.
 - 4. Equipment supports.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles below where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Grinnell Corp.
 - 3. National Pipe Hanger Corporation.
 - 4. Piping Technology & Products, Inc.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Power-Strut Div.; Tyco International, Ltd.
 - 3. Thomas & Betts Corporation.
 - 4. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
 - 1. Carpenter & Paterson, Inc.
 - 2. Erico/Michigan Hanger Co.
 - 3. PHS Industries, Inc.
 - 4. Pipe Shields, Inc.
 - 5. Rilco Manufacturing Company, Inc.
 - 6. Value Engineered Products, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass. At contractor's option, provide Pipe-Covering Protection Saddles (MSS Type 39) in lieu of insulation inserts.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 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.

1. Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
 - c. Masterset Fastening Systems, Inc.

 - B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 1. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.
- 2.7 PIPE STAND FABRICATION
- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping and piping routed at grade.

 - 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.
 1. Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.

 - C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
 1. Manufacturers:
 - a. MIRO Industries.

 - D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 1. Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
 - c. Portable Pipe Hangers.
 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: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 1. Manufacturers:
 - a. Portable Pipe Hangers.
 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.

2.8 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.
- B. Manufacturers:
 - 1. C & S Mfg. Corp.
 - 2. HOLDRITE Corp.; Hubbard Enterprises.
 - 3. Samco Stamping, Inc.

2.9 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.10 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars with primer/paint or galvanized coatings matching adjoining or similar components indicated in Division 5 .
- B. Grout: Refer to Section 23 0500 "Common Work Results for Mechanical."

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified 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 nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Size hangers and supports to match OD of pipe insulation.
- G. 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 noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, 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 24, 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 noninsulated stationary pipes, NPS 3/4 to NPS 8.
 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated 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.
 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 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 2 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 20, 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.
- H. 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 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- I. 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.
- J. 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-joist 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.
- K. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Hot and cold insulated piping services: Thermal-Hanger Shield Inserts.
 2. Hot insulated piping services 4" and larger, contractor's option: Steel Pipe-Covering Protection Saddles (MSS Type 39). Fill interior voids with insulation that matches adjoining insulation.
- L. 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 absorb 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 absorb 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 absorb 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.
- M. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- N. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- P. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel 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 building structure.
- B. 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 above for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger and provide sheet metal shield for insulated piping (cold services).
- E. 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.
- F. Pipe Stand Installation:
1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Section 07 7200 "Roof Accessories" for curbs.
- G. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Sections for plumbing fixtures.
- H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. 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.
- K. 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.
- L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- N. Insulated Piping:
1. Install thermal-hanger shield inserts at each support location for hot and cold services.
 2. At contractor's option, install sheet metal shield only for hot service piping less than 4".
 3. Sheet Metal Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long.
 - b. NPS 4: 12 inches long.
 - c. NPS 5 and NPS 6: 18 inches long.
 - d. NPS 8 to NPS 24: 24 inches long.
 4. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- 3.3 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 smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 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 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 contours of welded surfaces match adjacent contours.

3.5 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.

3.6 PAINTING

- A. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 painting sections.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 23 0548

MECHANICAL VIBRATION 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. This Section includes the following:
1. Isolation pads.
 2. Isolation mounts.
 3. Freestanding and restrained spring isolators.
 4. Horizontal thrust restraints.
 5. Elastomeric hangers.
 6. Spring hangers.
 7. Spring hangers with vertical-limit stops.
 8. Pipe riser resilient supports.
 9. Resilient pipe guides.
 10. Resilient washer-bushings.
 11. Steel and inertia vibration isolation equipment bases.
- B. Related Sections include the following:
1. Section 23 0500 "Common Work Results for Mechanical" for hydronic piping flexible connectors.
 2. Section 23 2300 "Refrigerant Piping" for piping flexible connectors in refrigerant piping systems.
 3. Section 23 3300 "Air Duct Accessories" for flexible duct connectors.

1.3 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
1. Basic Wind Speed: 90 miles per hour.
 2. Building Classification Category: II.
 3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
- B. Ductwork: Ductwork isolation requirements are based on duct equivalent diameters. For rectangular ductwork, the equivalent diameter is the diameter of round duct having the same cross-sectional area, given by the formula:
1. $EFFECTIVE_DIAMETER = 2 \times \text{square-root}(\text{DIMENSION}_1 \times \text{DIMENSION}_2 / \pi)$
- C. Equipment Isolation Frames and Bases: Frames and bases used to support vibration-isolated pumps shall be sized to provide support for pipe elbows.

- D. Isolation/Absorption Products: The completed installation shall be free of vibration and noise. Systems, equipment, or parts which vibrate or generate vibration unduly, or which generate or emit undue noise while in operation, shall: (1) be adjusted, repaired, or replaced as appropriate to obtain acceptable levels of vibration or noise, or (2) be supported on, or fitted with, suppression or absorption devices, or other means, which effectively prevent the transmission of vibration or noise beyond the offending item.
- E. Isolated equipment often has non-uniform load distribution. Ensure that appropriately sized isolators are selected to provide uniform loading and deflection meeting the minimum static deflections provided in the isolation schedule given at the end of this Section.
 - 1. Use minimum of 4 isolators to support each piece of equipment.
- F. Ensure that equipment support structure has no fundamental resonance frequency within plus or minus 40 percent of equipment operating speeds.
- G. Ensure no metal-to-metal contact occurs between fixed and floating components.
- H. Protect elastomeric components from exposure to high temperature.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated load, rated deflection, isolation efficiency based on lowest speed, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, weight, dimensions (including height at no load and operating load), and finish for each type and size of vibration isolation device required.
 - a. Annotate to indicate application of each product submitted and compliance with requirements. Include itemized list showing items to be isolated, the isolator type, model number, isolator loading and deflection, and reference to specific drawing showing frame construction where applicable
- B. Shop Drawings:
 - 1. Methods for suspension of support and guides.
 - 2. Methods for isolation of piping, at penetrations of walls, slabs, and beams.
 - 3. Detail fabrication and assembly of equipment bases, including dimensions, structural member sizes, and support point locations. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - a. Written approval of the frame design to be used shall be obtained from the equipment manufacturer.
 - 4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal (For Equipment Mounted Outdoors): For vibration isolation details 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. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, wind forces required to select vibration isolators, wind restraints, and for designing vibration isolation bases.

- a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
2. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
3. Wind-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
 - b. Coordinate vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.

D. Welding certificates.

E. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Amber/Booth Company, Inc.
 2. Kinetics Noise Control.
 3. Mason Industries.
 4. Vibration Mountings & Controls, Inc.
- B. General:
 1. Isolators installed outdoors shall have base plates with bolt holes for fastening the isolators to the support members.
 2. Isolator types are scheduled to establish minimum standards. At the Subcontractor's option, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevation during installation and initial system filling operations, and similar installation advantages. Accessories shall not degrade the vibration isolation system.
 3. The use of nested springs within a single mount is not permitted.
- C. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 1. Resilient Material: Oil- and water-resistant neoprene.
 2. Thickness: Minimum 5/16 inches.
 3. Maximum Durometer: 50.

- D. Mounts: Double-deflection type, with molded, oil-resistant neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
 - a. Maximum Durometer: 70.
- E. Spring Isolators: 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 for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate 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.
- F. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Limit stop as required for equipment.
 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.
- G. Horizontal Thrust Restraints: Modified Spring Isolator, with rod and angle brackets.
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 2. Maximum Movement: 1/4-inch from stop to maximum thrust.
 3. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 4. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside, with integral neoprene bushing and precompression stop nut.
 5. End Plate and Adjustment Bolt: Threaded end plate with adjustment bolt and cap screw.
 6. Deflection: Match spring isolators.
- H. Elastomeric Hangers: Double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

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. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 3. Maximum Durometer: 70.
- I. Spring Hangers: 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. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- J. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
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.
 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.
- K. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.
- L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.
- M. Resilient Washer-Bushings: Molded, oil resistant bridge bearing neoprene.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
 2. Kinetics Noise Control.
 3. Mason Industries.
 4. Vibration Mountings & Controls, Inc.
- B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.3 FACTORY FINISHES

- A. Finish (where field painting of mechanical items is specified in Division 09): Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish (where field painting of mechanical items is not specified in Division 09): Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
1. Powder coating on springs.
 2. All hardware shall be galvanized.
 3. Hot-dip galvanize metal components on isolators (except springs) for exterior use.
 4. Baked enamel or powder coat for metal components on isolators for interior use.
 5. Color-code or otherwise mark vibration isolation and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- 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. Comply with requirements in Section 07 7200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Install resilient washer-bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- C. Install resilient washer-bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- D. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.
- E. Fill inertia bases with 3000 psi concrete trowel to a smooth finish. Cast-in-place concrete materials and placement requirements are specified in Division 03.
- F. Align vibration isolators squarely above or below mounting points of the supported equipment.
- G. For equipment with bases, locate isolators on the sides of the base that are parallel to the equipment shaft.

- H. Isolator base plates shall rest entirely on the housekeeping pad.
- I. Equipment Isolator Installation:
 - 1. Space saver brackets shall be used for equipment supported on spring isolators.
 - 2. The minimum operating clearance between the underside of the frame or inertia base and the pad or floor shall be 1 inch (25mm).
 - 3. The frame shall be placed in position and supported temporarily by shims prior to the installation of the machine or isolators.
 - 4. After the entire system installation is completed and under full operational load, the isolators shall be adjusted so that the load is transferred from the shims to the isolators. When all isolators are properly adjusted, the shims will be barely free and shall be removed.
- J. Thrust Restraints:
 - 1. Thrust restraints shall be oriented parallel to the direction of thrust and located symmetrically about the center of thrust. Ducting at thrust restraints shall be designed to withstand thrust loading or an auxiliary structure shall be provided for thrust restraint mounting.
 - 2. Thrust restraint shall not interfere with or restrict free operation of vibration isolation systems.
- K. Resilient Wall, Ceiling, and Floor Penetrations: Provide resilient wall and ceiling penetrations for piping, conduit, ductwork, etc. supported on spring isolators. Refer to resilient penetration details on the Drawings.
- L. Position vibration isolation hangers as high as possible in the hanger rod assembly but not in contact with the building structure. Provide 1-inch minimum clearance between hanger housing and structure above. Provide side clearance for hanger housings to allow a full 360-degree rotation about the rod axis without contacting any object.
- M. Parallel pipes may be hung together on a trapeze that is isolated from the structure. Isolator deflections must equal the greatest deflection for those pipes if isolated individually. Do not mix isolated and non-isolated pipes on the same trapeze.
- N. Do not hang or support piping, ductwork, conduit or mechanical equipment on other equipment, pipes or ductwork installed on vibration isolators. Maintain 2-inch clearance between isolated equipment and walls, ceilings and other equipment. Do not allow drain piping connected to vibration-isolated equipment to contact the building structure or other non-isolated systems unless it is resiliently mounted.
- O. DX Unit Refrigerant Lines: Install flexible metal pipe connectors in two planes 90 degrees to each other in refrigerant lines. Flexible connectors shall have a burst pressure of four times operating pressure.
- P. Flexible Ductwork Connectors: Provide flexible ductwork connectors in ductwork at the point where it is connected to externally isolated air handling unit casings, exhaust fans, rooftop exhaust fans, fan coils or any other vibration-isolated equipment. Install these connectors between the equipment and the first associated duct support or hanger.
- Q. Flexible Piping Connectors: Provide flexible piping connectors in piping where it is connected to vibration-isolated equipment. Install these connectors between the equipment and the first

associated pipe support or hanger, except where supports connect to an inertia base common to the equipment.

- R. The installation or use of vibration isolators shall not cause any change of position of piping which will result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, maintain equipment and piping in a rigid position during installation. Do not transfer the load to the isolators until the installation is complete and under full operational load.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage the isolator manufacturer or their authorized representative to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, and with at least seven days' advance notice.
 - 3. Test equipment isolators and first four associated vibration isolation hangers from each equipment connection.
 - 4. Measure isolator restraint clearance.
 - 5. Measure isolator deflection.
 - 6. Inspect vibration control devices and remove paint splatters, spots, dirt, and debris.
 - 7. Vibration testing is specified in Section 23 0593 "Testing, Adjusting, and Balancing for HVAC."
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports and submit to architect.

3.4 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators so that isolated equipment is level and in proper alignment with connecting ducts and pipes.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.
- E. Attach thrust restraints at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.

3.5 MECHANICAL VIBRATION-CONTROL DEVICE SCHEDULE

ITEM DESCRIPTION	ISOLATOR AND BASE TYPE	MIN. STATIC DEFLECTION (INCHES)	
		Slab On Grade	Floor Span
PIPING			
First three supports near equipment isolated with springs	Spring Hangers with Vertical Limit Stops (suspended); Restrained Spring Isolators (floor mounted)	(Note 3)	(Note 3)
First three supports near equipment isolated with pads and mounts, and non-isolated equipment	Elastomeric Hangers (suspended); Isolation Mounts (floor mounted)	0.35	0.35
After first three supports within 50 feet of isolated equipment and not within mechanical rooms	Elastomeric Hangers (suspended); Isolation Mounts (floor mounted)	0.35	0.35
After first three supports of isolated equipment and within mechanical rooms	Spring Hangers with Vertical Limit Stops (suspended); Restrained Spring Isolators (floor mounted)	1.0	1.0
Pipe Risers and Guides within 50 feet of isolated equipment	Pipe Riser Resilient Support and Resilient Pipe Guides	--	0.35
Pipe Risers at Floor Penetrations beyond 50 feet of isolated equipment	Pad	0.25	0.25
Connections to isolated equipment, NPS 2 and larger, generally	Stainless-Steel Bellows Flexible Connectors	--	--
PUMPS			
Separately coupled, base mounted, end suction	Spring Isolators and Inertia Base	0.75	1.5
Close coupled, in-line and circulator, suspended	Elastomeric Hangers	--	0.75
Packaged pump systems	Spring Isolators	0.75	1.5
DUCTWORK			
First two supports near equipment isolated with springs	Spring Hangers (suspended); Spring Isolators (floor mounted)	(Note 3)	(Note 3)
First two supports near equipment isolated with pads and mounts, and non-isolated equipment	Elastomeric Hangers (suspended); Isolation Mounts (floor mounted)	0.35	0.35
After first two supports, within 50 feet of isolated equipment, or within mechanical rooms (whichever is greater)	Elastomeric Hangers (suspended); Isolation Mounts (floor mounted)	0.35	0.35
Connections to externally isolated equipment	Flexible Duct Connectors and Horizontal Thrust Restraints	(Note 3)	(Note 3)
Connections to internally isolated equipment without integral flexible duct connectors	Flexible Duct Connectors and Horizontal Thrust Restraints	(Note 3)	(Note 3)
FANS			

ITEM DESCRIPTION	ISOLATOR AND BASE TYPE	MIN. STATIC DEFLECTION (INCHES)	
		Slab On Grade	Floor Span
Within factory fabricated air-handling units (furnished by AHU manufacturer)	Spring Isolators, Horizontal Thrust Restraints, and Inertia Base	--	(Note 1)
Suspended, up to 22-inch diameter	Spring Hangers	--	0.75
Suspended, above 22-inch diameter	Spring Hangers	--	(Note 1)
Floor or roof-mounted, up to 22-inch diameter	Spring Isolators and Steel Base	0.75	0.75
Floor or roof mounted, above 22-inch diameter	Spring Isolators and Steel Base	(Note 1)	(Note 1)
FAN RPM SCHEDULE			
Up to 300 RPM	--	2.5	3.5
301 – 500 RPM	--	1.5	2.5
501 RPM and above	--	1.0	1.5
CONDENSING UNITS			
Mounted on floor or roof span	Restrained Spring Isolators	--	1.5
SUSPENDED FAN COIL UNITS, AIR CONDITIONING UNITS, AND UNIT HEATERS,	Spring Hangers	--	0.75
AIR SEPARATORS	Spring Hangers	--	0.75
PLATE AND FRAME HEAT EXCHANGER, EXPANSION TANKS, DOMESTIC WATER HEATERS	Pad	0.25	0.25

NOTES:

1. Refer to Fan RPM Schedule for minimum static deflection. Select deflection based on minimum speed (rpm) anticipated for fans with variable frequency controllers or multi-speed motors.
2. The spring hangers shall carry vertical load; the restrained spring isolators provide lateral support only.
3. Static deflection equal to the isolators supporting the equipment.

END OF SECTION

SECTION 23 0553

IDENTIFICATION FOR MECHANICAL

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. This Section includes the following mechanical identification materials and their installation:
 - 1. Equipment nameplates.
 - 2. Equipment markers.
 - 3. Access panel and door markers.
 - 4. Pipe markers.
 - 5. Duct markers.
 - 6. Stencils.
 - 7. Valve tags.
 - 8. Valve schedules.
 - 9. Warning tags.
- B. Related Sections include the following:
 - 1. Section 01 8113 "Sustainable Design Requirements" for additional requirements related to the LEED certification process.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Valve numbering scheme.
- C. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.
- D. LEED Submittals:
 - 1. Credit EQ 4.2: Manufacturers' product data for paints and coatings, demonstrating compliance with low-emitting materials requirements

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

- 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 location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Marking Services, Inc.
 - 3. Seton Identification Products.

2.2 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, factory installed on equipment.
 - 1. Data:
 - a. Manufacturer, product name, model number, and serial number.
 - b. Capacity, operating and power characteristics, and essential data.
 - c. Labels of tested compliances.
 - 2. Location: Accessible and visible.
 - 3. Fasteners: As required to mount on equipment.
- B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive, or self-tapping stainless steel screws.
 - 1. Terminology: Match schedules as closely as possible.
 - 2. Data:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
 - 3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.
- C. Access Panel and Door Markers: 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.
 - 1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.3 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
 - 1. Colors: Comply with ASME A13.1, unless otherwise indicated.
 - a. Rainwater harvesting systems shall be purple in color.
 - 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 - 3. Length of Marker and Letter Sizes: Comply with applicable WSSC Plumbing & Fuel Gas Code.
 - 4. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.

5. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
 6. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
 7. Exterior Applications: UV rated and rated for exterior use, including ambient conditions from 0°F to 100°F.
- B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.
- C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.
- D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.
- E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door markers, and similar operational instructions.
1. Stencil Material: Metal or fiberboard.
 2. Stencil Paint: Exterior, gloss, acrylic enamel black, unless otherwise indicated. Paint may be in pressurized spray-can form.
 3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1, unless otherwise indicated.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Architect. Provide 5/32-inch hole for fastener.
1. Material: 0.032-inch- thick brass.
 2. Valve-Tag Fasteners: Brass wire-link chain.

2.6 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size 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.
1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
 2. Frame: Extruded aluminum.

3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.7 WARNING TAGS

- A. Warning Tags: 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: Yellow background with black lettering.

2.8 PLUMBING FIXTURE AND ROOM SIGNAGE

- A. General: In accordance with Section 10 1423 "Panel Signage"

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
 1. Pumps, compressors, condensers, and similar motor-driven units.
 2. Heat exchangers, coils, evaporators, and similar equipment.
 3. Fans, blowers, and primary balancing dampers.
 4. Packaged HVAC central-station and zone-type units.
 5. Domestic water heaters, expansion/compression tanks.
- B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment.
 1. Letter Size: Minimum 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.
 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. Meters, gages, thermometers, and similar units.
 - c. Pumps, compressors, condensers, and similar motor-driven units.
 - d. Heat exchangers, coils, evaporators, and similar equipment.

- e. Fans, blowers, and primary balancing dampers.
- f. Packaged HVAC central-station and zone-type units.
- g. Tanks and pressure vessels.
- h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.
- i. ATC panels, controllers, valves, dampers, sensors, etc.
- j. Air handling units to identify associated exhaust fan systems, if applicable.

- C. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
 - 1. Exterior Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
 - 2. Interior Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
 - 3. Exterior Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
 - 4. Interior Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed 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 nonaccessible 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 markers.

3.4 DUCT IDENTIFICATION

- A. Install stenciled markers on ductwork:
 - 1. Stenciled Duct Marker: Stenciled markers, showing designation of equipment serving ducts (AHU-1, etc.), service (supply-air, etc.) and direction of flow. Note associated air handling units or exhaust fans on systems that tie together for heat recovery.
- B. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves immediately adjacent to factory-fabricated equipment units; and HVAC terminal devices 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:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water (HVAC and Plumbing): 1-1/2 inches, round.
 - b. Hot Water (HVAC and Plumbing): 1-1/2 inches, round.
 - 2. Valve-Tag Color:
 - a. Cold Water (HVAC and Plumbing): Green.
 - b. Hot Water (HVAC and Plumbing): Yellow.
 - 3. Letter Color:
 - a. Cold Water: White.
 - b. Hot Water: Black.

3.6 VALVE-SCHEDULE INSTALLATION

- A. Mount valve schedule on wall in accessible location in each major equipment room.

3.7 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

3.8 PLUMBING FIXTURE SIGNAGE

- A. General: At Each Non-Potable Outlets, including Hose Connections, and Other Outlet Connection, sign to read "Non-Potable – Not Safe For Drinking" or other approved wording.

3.9 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.10 CLEANING

- A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION

SECTION 23 0593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

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. This Section includes Testing, Adjusting, and Balancing (TAB) to produce design objectives for the following:
 - 1. Air Systems:
 - a. Constant-volume air systems.
 - 2. Hydronic Piping Systems:
 - a. Constant-flow systems.
 - b. Variable-flow systems.
 - c. Primary-secondary systems.
 - 3. Domestic hot water constant-flow systems.
 - 4. HVAC equipment quantitative-performance settings.
 - 5. Vibration measuring.
 - 6. Sound level measuring.
 - 7. Verifying that automatic control devices are functioning properly.
 - 8. Witnessing duct leakage testing.
 - 9. Reporting results of activities and procedures specified in this Section.
- B. Related Sections include the following:
 - 1. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - a. Section 01 9113 "General Commissioning Requirements."
 - b. Section 23 0800 "Commissioning of Mechanical Systems".

1.3 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

- E. NC: Noise criteria.
- F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- G. RC: Room criteria.
- H. Report Forms: Test data sheets for recording test data in logical order.
- I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- M. TAB: Testing, adjusting, and balancing.
- N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- O. Test: A procedure to determine quantitative performance of systems or equipment.
- P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

- A. Qualification Data: Within 45 days from Contractor's Notice to Proceed, submit evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 45 days from Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 90 days from Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project, certification of instrument calibration, and instrument serial numbers.
- D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- E. Ceiling Coordination Shop Drawings:
 - 1. Access doors will not be provided for supply and return air devices in gypsum board or plaster ceilings.

2. Submit to the Construction Manager, ceiling coordination drawings for areas with hard gypsum board or plaster ceilings. Drawings shall indicate both minimum and maximum allowable areas of ceilings to be installed prior to testing and balancing of supply and return air devices and associated volume dampers. Minimum area shall be enough ceiling to allow testing and balancing to occur and assure the same air device performance once the ceilings are complete. Maximum area shall leave enough openings in the ceiling to access volume dampers and other components necessary to test and balance.
3. Utilize sheet metal installation drawings as base plans for ceiling coordination drawings. Sheetmetal installation drawings are specified in Section 23 3113 "Metal Ducts."

F. Certified duct pressure test reports.

G. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
 - a. Submittal distribution requirements.
 - b. The Contract Documents examination report.
 - c. TAB plan.
 - d. Work schedule and Project-site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.
 - f. Coordination of documentation and communication flow.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing."

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.
- D. Coordinate partial installation of gypsum wall board and plaster ceilings to permit balancing of supply and exhaust air devices without use of access doors.

1.7 WARRANTY

- A. Provide one of the following:
 1. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
 - a. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 - b. Systems are balanced to optimum performance capabilities within design and installation limits.
 2. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
 - a. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 - b. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
 1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
 2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing

devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine Project Record Documents described in Section 01 7200 "Project Record Documents."
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- G. Examine system and equipment test reports.
- H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
- L. Examine strainers for clean screens and proper perforations.
- M. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- O. Examine system pumps to ensure absence of entrained air in the suction piping.
- P. Examine equipment for installation and for properly operating safety interlocks and controls.

- Q. Examine automatic temperature system components to verify the following:
1. Dampers, valves, and other controlled devices are operated by the intended controller.
 2. Dampers and valves are in the position indicated by the controller.
 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in mixing boxes and variable-air-volume terminals.
 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 6. Sensors are located to sense only the intended conditions.
 7. Sequence of operation for control modes is according to the Contract Documents.
 8. Controller set points are set at indicated values.
 9. Interlocked systems are operating.
 10. Changeover from heating to cooling mode occurs according to indicated values.
- R. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
1. Permanent electrical power wiring is complete.
 2. Hydronic systems are filled, clean, and free of air.
 3. Automatic temperature-control systems are operational.
 4. Equipment and duct access doors are securely closed.
 5. Balance, smoke, and fire dampers are open.
 6. Isolating and balancing valves are open and control valves are operational.
 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing"; and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling unit components.
- L. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each component that makes up an air-handling unit and other air-handling and -treating equipment.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - 3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
 - 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with

- calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure terminal outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.
- ### 3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS
- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. For variable-flow systems, develop a plan to simulate diversity.
- D. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
1. Open all manual valves for maximum flow.
 2. Check expansion tank liquid level.
 3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation and set at indicated flow.
 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.

6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.7 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 4. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set calibrated balancing valves, if installed, at calculated presettings.
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
 1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 3. Record settings and mark balancing devices.
- F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- G. Measure the differential-pressure control valve settings at the conclusion of balancing.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.
- B. Compensation for diversity: When the total water flowrate of all terminal equipment and coils is more than the indicated zone balancing valve flowrate or pump flowrate, place a selected number of terminal equipment at a maximum setpoint water flowrate condition until the total

water flowrate of the terminal equipment equals the indicated balancing valve flowrate or pump flowrate. Select the reduced flowrate terminal equipment so they are distributed evenly among the branch piping.

- C. Do not throttle pump discharge valve if a variable frequency controller is provided.
- D. Measure differential pressure at the most critical coil and adjust the setpoint at each differential-pressure transmitter to ensure that adequate differential-pressure is maintained at the most critical coil. Coordinate setpoint with BAS Contractor.

3.9 PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS

- A. Balance the primary system crossover flow first, then balance the secondary system.

3.10 PROCEDURES FOR HEAT EXCHANGERS

- A. Measure water flow through all circuits.
- B. Adjust water flow to within specified tolerances.
- C. Measure inlet and outlet water temperatures.
- D. Measure inlet steam pressure.
- E. Check the setting and operation of safety and relief valves. Record settings.

3.11 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer, model, and serial numbers.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Efficiency rating.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller (if provided) to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.12 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Water Coils: Measure the following data for each coil:
 - 1. Entering- and leaving-water temperature.
 - 2. Water flow rate.
 - 3. Water pressure drop.
 - 4. Dry-bulb temperature of entering and leaving air.
 - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 6. Airflow.
 - 7. Air pressure drop.
- B. Refrigerant Coils: Measure the following data for each coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Wet-bulb temperature of entering and leaving air.
 - 3. Airflow.
 - 4. Air pressure drop.
 - 5. Refrigerant suction pressure and temperature.

3.14 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in five separately controlled zones of each of the following space types to prove correctness of final temperature settings. Measure when the building or zone is occupied.
 - 1. Private office.
 - 2. Open office area.
 - 3. Conference room.
 - 4. Lecture hall.
 - 5. Classroom.
 - 6. Atrium
 - 7. Chemistry Lab.
- C. Measure outside-air, wet- and dry-bulb temperatures.
- D. Coordinate temperature measurements with instruments and sensors calibration specified in Section 23 0900 "Instrumentation and Control for HVAC."

3.15 PROCEDURES FOR VIBRATION MEASUREMENTS

- A. Use a vibration meter meeting the following criteria:
 - 1. Solid-state circuitry with a piezoelectric accelerometer.
 - 2. Velocity range of 0.1 to 10 inches per second.
 - 3. Displacement range of 1 to 100 mils.
 - 4. Frequency range of at least 0 to 1000 Hz.
 - 5. Capable of filtering unwanted frequencies.
- B. Calibrate the vibration meter before each day of testing.
 - 1. Use a calibrator provided with the vibration meter.
 - 2. Follow vibration meter and calibrator manufacturer's calibration procedures.

- C. Perform vibration measurements when other building and outdoor vibration sources are at a minimum level and will not influence measurements of equipment being tested.
 - 1. Turn off equipment in the building that might interfere with testing.
 - 2. Clear the space of people.
- D. Perform vibration measurements after air and water balancing and equipment testing is complete.
- E. Clean equipment surfaces in contact with the vibration transducer.
- F. Position the vibration transducer according to manufacturer's written instructions and to avoid interference with the operation of the equipment being tested.
- G. Measure and record vibration on rotating equipment over 3 hp.
- H. Measure and record equipment vibration, bearing vibration, equipment base vibration, and building structure vibration. Record velocity and displacement readings in the horizontal, vertical, and axial planes.
 - 1. Pumps:
 - a. Pump Bearing: Drive end and opposite end.
 - b. Motor Bearing: Drive end and opposite end.
 - c. Pump Base: Top and side.
 - d. Building: Floor.
 - e. Piping: To and from the pump after flexible connections.
 - 2. Fans and HVAC Equipment with Fans:
 - a. Fan Bearing: Drive end and opposite end.
 - b. Motor Bearing: Drive end and opposite end.
 - c. Equipment Casing: Top and side.
 - d. Equipment Base: Top and side.
 - e. Building: Floor.
 - f. Ductwork: To and from equipment after flexible connections.
 - g. Piping: To and from equipment after flexible connections.
 - 3. HVAC Equipment with Compressors:
 - a. Compressor Bearing: Drive end and opposite end.
 - b. Motor Bearing: Drive end and opposite end.
 - c. Equipment Casing: Top and side.
 - d. Equipment Base: Top and side.
 - e. Building: Floor.
 - f. Piping: To and from equipment after flexible connections.
- I. For equipment with vibration isolation, take floor measurements with the vibration isolation blocked solid to the floor and with the vibration isolation floating. Calculate and report the differences.
- J. Inspect, measure, and record vibration isolation.
 - 1. Verify that vibration isolation is installed in the required locations.
 - 2. Verify that installation is level and plumb.
 - 3. Verify that isolators are properly anchored.
 - 4. For spring isolators, measure the compressed spring height, the spring OD, and the travel-to-solid distance.

5. Measure the operating clearance between each inertia base and the floor or concrete base below. Verify that there is unobstructed clearance between the bottom of the inertia base and the floor.

3.16 PROCEDURES FOR SOUND-LEVEL MEASUREMENTS

- A. Perform sound-pressure-level measurements with an octave-band analyzer complying with ANSI S1.4 for Type 1 sound-level meters and ANSI S1.11 for octave-band filters. Comply with requirements in ANSI S1.13, unless otherwise indicated.
- B. Calibrate sound meters before each day of testing. Use a calibrator provided with the sound meter complying with ANSI S1.40.
- C. Use a microphone that is suitable for the type of sound levels measured. For areas where air velocities exceed 100 fpm, use a windscreen on the microphone.
- D. Perform sound-level testing after air and water balancing and equipment testing are complete.
- E. Close windows and doors to the space.
- F. Perform measurements when the space is not occupied and when the occupant noise level from other spaces in the building and outside are at a minimum.
- G. Clear the space of temporary sound sources so unrelated disturbances will not be measured. Position testing personnel during measurements to achieve a direct line-of-sight between the sound source and the sound-level meter.
- H. Take sound measurements at a height approximately 48 inches above the floor and at least 36 inches from a wall, column, and other large surface capable of altering the measurements.
- I. Take sound measurements in dBA and in each of the 8 unweighted octave bands in the frequency range of 63 to 8000 Hz.
- J. Take sound measurements with the HVAC systems off to establish the background sound levels and take sound measurements with the HVAC systems operating.
 1. Calculate the difference between measurements. Apply a correction factor depending on the difference and adjust measurements.
- K. Perform sound testing at locations on Project for each of the following space types. For each space type tested, select a measurement location that has the greatest sound level. If testing multiple locations for each space type, select at least one location that is near and at least one location that is remote from the predominant sound source. Test sound levels after all phases of project are complete. Coordinate with Owner for selection of spaces to be tested.
 1. Private office.
 2. Prayer room.
 3. Dining room.
 4. Lounge.
 5. Inside each mechanical equipment room.

3.17 ADDITIONAL TESTING

1. Perform the following tests:

- a. Wheel leakage for each air handling unit. Measure at design outside airflow and relief/exhaust airflow.
- b. Test pumps associated with all plumbing systems, including RO System, Solar Thermal System, Booster Pumps, Rainwater Harvesting System, etc. Pumps shall be tested according to the procedures specified herein.

3.18 DUCT LEAKAGE TESTING

- A. Witness leakage tests of ductwork. Duct leakage tests are specified in Section 23 3113 "Metal Ducts."

3.19 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
 - 2. Air Outlets and Inlets: 0 to minus 10 percent.
 - 3. Heating-Water Flow Rate: 0 to minus 10 percent.
 - 4. Cooling-Water Flow Rate: 0 to minus 5 percent.
- B. Set fan bearing vibration within the following tolerances:

Fan RPM (peak to peak)	Mils (peak to peak)
Under 600	4.0
600 – 800	3.0
801 – 1200	2.3
1201 - 2000	2.0
Over 2000	1.0

3.20 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.21 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.

- C. Final Report Contents: In addition to certified field report data, include the following:
1. Pump curves.
 2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
1. Title page.
 2. Name and address of TAB firm.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB firm who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer, type size, and fittings.
 14. Notes to explain why certain final data in the body of reports varies from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Variable frequency controller settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.

- c. Make and type.
- d. Model number and unit size.
- e. Manufacturer's serial number.
- f. Unit arrangement and class.
- g. Discharge arrangement.
- h. Sheave make, size in inches, and bore.
- i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
- j. Number of belts, make, and size.
- k. Number of filters, type, and size.
- 2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
- 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat coil static-pressure differential in inches wg.
 - g. Cooling coil static-pressure differential in inches wg.
 - h. Heating coil static-pressure differential in inches wg.
 - i. Humidifier dispersion manifold static-pressure differential in inches wg.
 - j. Outside airflow in cfm.
 - k. Return airflow in cfm.
 - l. Outside-air damper position.
 - m. Return-air damper position.
- G. Apparatus-Coil Test Reports:
 - 1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft..
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outside-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.

- j. Entering-water temperature in deg F.
 - k. Leaving-water temperature in deg F.
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in deg F.
- H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - g. Number of belts, make, and size.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
- 1. Report Data:
 - a. System and air-handling unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- J. Air-Terminal-Device Reports:
- 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Test apparatus used.
 - d. Area served.
 - e. Air-terminal-device make.

- f. Air-terminal-device number from system diagram.
 - g. Air-terminal-device type and model number.
 - h. Air-terminal-device size.
 - i. Air-terminal-device effective area in sq. ft..
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- L. Compressor and Condenser Reports: For refrigerant side of unitary systems, and air-cooled condensing units include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Unit make and model number.
 - d. Compressor make.
 - e. Compressor model and serial numbers.
 - f. Refrigerant weight in lb.
 - g. Low ambient temperature cutoff in deg F.
 - 2. Test Data (Indicated and Actual Values):
 - a. Inlet-duct static pressure in inches wg.
 - b. Outlet-duct static pressure in inches wg.
 - c. Entering-air, dry-bulb temperature in deg F.
 - d. Leaving-air, dry-bulb temperature in deg F.
 - e. Control settings.
 - f. Unloader set points.
 - g. Low-pressure-cutout set point in psig.
 - h. High-pressure-cutout set point in psig.
 - i. Suction pressure in psig.
 - j. Suction temperature in deg F.
 - k. Condenser refrigerant pressure in psig.
 - l. Condenser refrigerant temperature in deg F.
 - m. Oil pressure in psig.
 - n. Oil temperature in deg F.

- o. Voltage at each connection.
 - p. Amperage for each phase.
 - q. Kilowatt input.
- M. Heat-Exchanger/Converter Test Reports: For steam and hot-water heat exchangers, include the following:
- 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and type.
 - e. Model and serial numbers.
 - f. Ratings.
 - 2. Steam Test Data (Indicated and Actual Values):
 - a. Inlet pressure in psig.
 - b. Condensate flow rate in lb/h.
 - 3. Primary Water Test Data (Indicated and Actual Values):
 - a. Entering-water temperature in deg F.
 - b. Leaving-water temperature in deg F.
 - c. Entering-water pressure in feet of head or psig.
 - d. Water pressure differential in feet of head or psig.
 - e. Water flow rate in gpm.
 - 4. Secondary Water Test Data (Indicated and Actual Values):
 - a. Entering-water temperature in deg F.
 - b. Leaving-water temperature in deg F.
 - c. Entering-water pressure in feet of head or psig.
 - d. Water pressure differential in feet of head or psig.
 - e. Water flow rate in gpm.
- N. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
- 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model and serial numbers.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.

- e. Full-open pressure in feet of head or psig.
- f. Final discharge pressure in feet of head or psig.
- g. Final suction pressure in feet of head or psig.
- h. Final total pressure in feet of head or psig.
- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.

O. Vibration Measurement Reports:

1. Date and time of test.
2. Vibration meter manufacturer, model number, and serial number.
3. Equipment designation, location, equipment, speed, motor speed, and motor horsepower.
4. Diagram of equipment showing the vibration measurement locations.
5. Measurement readings for each measurement location.
6. Calculate isolator efficiency using measurements taken.
7. Description of predominant vibration source.

P. Sound Measurement Reports: Record sound measurements on octave band and dBA test forms and on an NC or RC chart indicating the decibel level measured in each frequency band for both "background" and "HVAC system operating" readings. Record each tested location on a separate NC or RC chart. Record the following on the forms:

1. Date and time of test. Record each tested location on its own NC curve.
2. Sound meter manufacturer, model number, and serial number.
3. Space location within the building including floor level and room number.
4. Diagram or color photograph of the space showing the measurement location.
5. Time weighting of measurements, either fast or slow.
6. Description of the measured sound: steady, transient, or tonal.
7. Description of predominant sound source.

Q. Instrument Calibration Reports:

1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.22 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Measure sound levels at two locations.
 - e. Verify that balancing devices are marked with final balance position.
 - f. Note deviations to the Contract Documents in the Final Report.

- B. Final Inspection:
1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner.
 2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
 3. Owner shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
 4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
 5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
 6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
 7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.23 COMMISSIONING

- A. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
1. Section 01 9113 "General Commissioning Requirements".
 2. Section 230800 "Commissioning of Mechanical Systems".

3.24 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions. Owner shall randomly select measurements to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.
- C. Air Measuring System Calibration Check: Compare transmitter output to traverse for Pitot tube and differential pressure probe transmitters every 6 months throughout the warranty period.

END OF SECTION

SECTION 23 0700.03
MECHANICAL INSULATION

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. This Section includes mechanical insulation for boiler breeching, duct, equipment, and pipe, including the following:
 - 1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 - d. Polyisocyanurate.
 - 2. Fire-rated insulation systems.
 - 3. Insulating cements.
 - 4. Adhesives.
 - 5. Mastics.
 - 6. Lagging adhesives.
 - 7. Sealants.
 - 8. Factory-applied jackets.
 - 9. Field-applied fabric-reinforcing mesh.
 - 10. Field-applied cloths.
 - 11. Field-applied jackets.
 - 12. Acoustical jacketing
 - 13. Removable, reusable insulation jackets.
 - 14. Tapes.
 - 15. Securements.
 - 16. Corner angles.
- B. Related Sections include the following:
 - 1. Section 23 3113 "Metal Ducts" for duct liners.
 - 2. Section 01 8113 "Sustainable Design Requirements" for additional requirements.

1.3 DEFINITIONS

- A. ASJ: All-service jacket.
- B. FSK: Foil, scrim, Kraft paper.
- C. FSP: Foil, scrim, polyethylene.
- D. PVDC: Polyvinylidene chloride.
- E. SSL: Self-sealing lap.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings: Show details for the following:
 - 1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Attachment and covering of heat tracing inside insulation, where applicable.
 - 3. Insulation application at pipe expansion joints for each type of insulation.
 - 4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Removable insulation at pumps.
 - 7. Application of field-applied jackets.
 - 8. Application at linkages of control devices.
 - 9. Field application for each equipment type.
- C. Installer Certificates: Signed by Contractor certifying that installers comply with requirements.
- D. LEED Submittals:
 - 1. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, demonstrating compliance with low-emitting materials requirements.
 - 2. Credit EQ 4.2: Manufacturers' product data for paints and coatings, demonstrating compliance with low-emitting materials requirements.
- E. Field quality-control inspection reports.

1.5 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. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting 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. Insulation materials shall be tested and rated according to ASTM Test Method C-177 to determine k-factors.

1.6 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.

- B. Protect all insulating materials from dirt, water and damage during storage and installation. Remove damaged, wet or otherwise unsatisfactory insulation at Architect's direction.

1.7 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Section 23 0529 "Hangers and Supports for Mechanical Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing, where applicable.

1.8 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles below where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 INSULATION MATERIALS

- A. Refer to Part 3 schedule articles for requirements about 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 C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products:
 - a. Cell-U-Foam Corporation; Ultra-CUF.
 - b. Pittsburgh Corning Corporation; Foamglas Super K.
 - c. Specialty Products & Insulation Company (SPI); Lancaster, PA.
 2. Block Insulation: ASTM C 552, Type I.
 3. Special-Shaped Insulation: ASTM C 552, Type III.
 4. Board Insulation: ASTM C 552, Type IV.
 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 6. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
 7. Maximum K-Factor: 0.29 at 75 deg. F. mean temperature.
 8. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials. Closed-cell polyolefin/polyethylene insulation is not acceptable as a substitution for ASTM C534 closed-cell rubber materials.
1. Products:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. Nomaco K-Flex; Insul-Sheet and Insul-Tube 180.
 2. Maximum K-Factor: 0.28 at 75 deg. F. mean temperature.
 3. Water Vapor Permeability: 0.02 perm-inch per ATM E96 Procedure A.
 4. Warranty: 25 year warranty against breakdown of the membrane due to ultraviolet radiation.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
1. Products:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Owens Corning; All-Service Duct Wrap.
 2. Maximum K-Factor: 0.29 at 75 deg. F. and material thickness compressed 25%.
 3. Minimum Density: 0.75 pounds per cubic foot.
- I. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
1. Products:
 - a. Johns Manville; HTB 23 Spin-Glas.
 - b. Owens Corning; High Temperature Flexible Batt Insulations.
 2. Maximum K-Factor: 0.23 at 75 deg. F.
 3. Minimum Density: 2.0 pounds per cubic foot.
- J. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
1. Products:
 - a. CertainTeed Corp.; Commercial Board.
 - b. Johns Manville; 800 Series Spin-Glas, Type 814.

- c. Knauf Insulation; Insulation Board.
 - d. Owens Corning; Fiberglas 700 Series.
 2. Maximum K-Factor: 0.23 at 75 deg. F. mean temperature.
 3. Minimum Density: 3.0 pounds per cubic foot.
- K. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
 1. Products:
 - a. Johns Manville; 1000 Series Spin-Glas.
 - b. Owens Corning; High Temperature Industrial Board Insulations.
 - c. Rock Wool Manufacturing Company; Delta Board.
 2. Maximum K-Factor: 0.23 at 75 deg. F mean temperature; 0.33 at 300 deg. F mean temperature.
 3. Minimum Density: 3.0 pounds per cubic foot.
- L. Mineral-Fiber, Preformed Pipe Insulation:
 1. Products:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000 (Pipe Insulation).
 - c. Owens Corning; Fiberglas Pipe Insulation.
 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 4. Maximum K-Factor: 0.23 at 75 deg. F mean temperature; 0.34 at 250 deg. F mean temperature.
- M. 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 C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 1. Products:
 - a. CertainTeed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Pipe and Tank Insulation.
 - d. Owens Corning; Fiberglas Pipe and Tank Insulation.
 2. Maximum K-Factor: 0.24 at 75 deg. F mean temperature; 0.39 at 300 deg. F mean temperature.
 3. Minimum Density: 2.5 pounds per cubic foot.
- N. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
 1. Products:
 - a. Apache Products Company; ISO-25.
 - b. Dow Chemical Company (The); Trymer 2000.
 - c. Duna USA Inc.; Corafoam.
 - d. Elliott Company; Elfoam.
 2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.
 3. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches as tested by ASTM E 84.

4. Fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 - a. Pipe Applications: ASJ-SSL, (for all duty except cold service in unconditioned areas) PVDC-SSL (for cold service in unconditioned areas).
 - b. Equipment Applications: ASJ-SSL, (for all duty except cold service in unconditioned areas) PVDC-SSL (for cold service in unconditioned areas).

2.3 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a 2-hour fire rating. Provide appropriate options for whether wrap is used for fume hood duct applications.
 1. Products:
 - a. CertainTeed Corp.; FlameChek.
 - b. Johns Manville; Firetemp Wrap.
 - c. 3M; Fire Master Wrap Products.

2.4 INSULATING CEMENTS

- A. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
- B. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 1. Products:
 - a. Insulco, Division of MFS, Inc.; Triple I.
 - b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
- C. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
 1. Products:
 - a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.
- D. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
 1. Products:
 - a. Insulco, Division of MFS, Inc.; SmoothKote.
 - b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
 - c. Rock Wool Manufacturing Company; Delta One Shot.

2.5 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
- C. Cellular-Glass and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 1. Products:
 - a. Childers Products; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-33/81-84.

- D. Flexible Elastomeric Adhesive.
 - 1. Products:
 - a. Armacell LCC; 520 BLV Adhesive.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - c. Childers Products; CP-82

- E. Mineral-Fiber Adhesive.
 - 1. Products:
 - a. Childers Products; CP-82/CP-127.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20/85-60.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Mon-Eco Industries, Inc.; 22-68.

- F. ASJ and FSK Adhesive: for bonding insulation jacket lap seams and joints.
 - 1. Products:
 - a. Childers Products; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20/85-60.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Mon-Eco Industries, Inc.; 22-68.

- G. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Red Devil, Inc.; Celulon Ultra Clear.
 - c. Speedline Corporation; 73-20 TRV Adhesive/Sealant.

2.6 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.

- B. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.

- C. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Products:
 - a. Childers Products; CP-34.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-80 AF.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - d. Marathon Industries, Inc.; 590.
 - e. Mon-Eco Industries, Inc.; 55-40.
 - f. Vimasco Corporation; 749.
 - 2. Coating: ASTM D 5590, 0 growth rating.
 - 3. Water-Vapor Permeance: ASTM F 1249, 0.08 perm at 37-mil dry film thickness tested at 100 degrees F and 90 % RH.
 - 4. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 5. Solids Content: ASTM D 1644, 48 percent by volume and 62 percent by weight.
 - 6. Color: White.

- D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Products:
 - a. Childers Products; CP-10/CP-11.
 - b. Foster Products Corporation, H. B. Fuller Company; 35-00/46-50.

- c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
- d. Marathon Industries, Inc.; 550.
- e. Mon-Eco Industries, Inc.; 55-50.
- f. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 1-3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 51 percent by volume and 64 percent by weight.
5. Color: White.

2.7 LAGGING ADHESIVES

- A. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
- B. Description: shall be compatible with insulation materials, jackets, and substrates.
 1. Products:
 - a. Childers Products; CP-137AF.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-36AF.
 2. Coating: ASTM D 5590, 0 growth rating.
 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
 4. Service Temperature Range: 0 to plus 180 deg F.
 5. Color: White.

2.8 SEALANTS

- A. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
- B. Joint Sealants:
 1. Joint Sealants for Cellular-Glass and Polyisocyanurate Products:
 - a. Childers Products; CP-76/CP-70.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-50/30-45.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
 - f. Vimasco Corporation; 750.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 4. Color: White, tan, or gray.
- C. FSK and Metal Jacket Flashing Sealants:
 1. Products:
 - a. Childers Products; CP-76.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Vimasco Corporation; 750.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: Aluminum.

- D. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 - 1. Products:
 - a. Childers Products; CP-76.
 - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 3. Fire- and water-resistant, flexible, elastomeric sealant.
 - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 5. Color: White.

2.9 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 C 1136, Type I.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C 1136, Type II.
 - 4. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 - 5. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 - 6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - a. Products:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 - 7. Vinyl Jacket: UL-rated white vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.10 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
- B. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.
 - 1. Products:
 - a. Childers Products; Chil-Glas No. 10.
 - b. Vimasco Corporation; Elastafab 894.
- C. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.
 - 1. Products:
 - a. Childers Products; Chil-Glas No. 5.
- D. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.

1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
 - b. Vimasco Corporation; Elastafab 894.

2.11 FIELD-APPLIED CLOTHS

- A. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
- B. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..
 1. Products:
 - a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.12 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
- C. PVC Jacket: High-impact-resistant, Flame-spread index of 25 or less, and smoke-developed index of 50 or less, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; 20 mil thickness; roll stock ready for shop or field cutting and forming.
 1. Products:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: As selected by Architect, from standard available color options. Color scheme will be generally as follow for exposed piping in Mechanical Rooms:
 - a. Primary Chilled Water: Blue
 - b. Secondary Chilled Water: Light Blue
 - c. Heating Hot Water: Yellow
 - d. Condenser Water: Gray
 - e. Domestic Cold Water, Domestic Hot Water and Hot Water Recirculating: Green
 - f. Industrial Cold Water, Industrial Hot Water and Hot Water Recirculating: Green
 - g. Compressed Air: Light Gray
 - h. Drain: Light Green
 - i. Hazardous Waste: Purple
 - j. Gas: Yellow
 - k. PVC jackets on services not indicated above: white
 4. Factory-fabricated fitting covers.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps and mechanical joints minimum 20 mil thickness.
 5. Factory-fabricated tank heads and tank side panels.
- D. Metal Jacket:
 1. Products:
 - a. Childers Products; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Thickness: 0.024 inch minimum.
 - c. Finish: Stucco-embossed finish.
 - d. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and Kraft paper.
 - e. Moisture Barrier for Outdoor Applications: 2.5-mil- thick Polysurlyn.
 - f. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

- E. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over rigid insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with stucco-embossed aluminum-foil facing.
 1. Products:
 - a. MFM Building Products Corp., Flex Clad 400.
 - b. Polyguard; Alumaguard 60.
 - c. Venture Tape, VentureClad 1577

- F. Rubber Membrane: 48-mil thick membrane consisting of a glass fiber carrier coated on both sides with liquid PVC-P Plastisol, and laminated to polyester fleece.
 1. Products:
 - a. Sarnafil G410-EL.

2.13 ACOUSTICAL JACKETS

- A. The barrier shall be constructed of a minimum 0.12" thick mass loaded, limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side. The barrier shall have a nominal minimum density of 1.0-psf and shall have a minimum STC rating of 28. The barrier shall exhibit minimum flammability ratings of 0.0-seconds for flame-out and after-glow, and minimum 0.2" for char length when tested in accordance with Federal Test Std. No. 191-5903. The barrier shall have a minimum thermal conductivity (K) value of 0.29 and a rated service temperature within the range of 40°F to 140°F. When tested for Surface Burning Characteristics per ASTM E84, the barrier will have a Flame Spread Index of no more than 10 and a Smoke Development Index of no more than 40.

- B. The decoupling layer shall be a combination of minimum 1.0" fiber glass batting, non-woven porous scrim-coated glass cloth, quilted together to encapsulate the glass fibers.

- C. The composite material shall be fabricated to include a nominal 6" wide barrier overlap tab extending beyond the fiber glass to facilitate a leak-tight seal around field joints.

- D. Acoustical jacket material shall be Kinetics Noise Control, Inc. Model KNM-100ALQ, or approved equal.

2.14 REMOVABLE, REUSABLE INSULATION JACKETS

- A. Insulation jacket with fiberglass internal insulation and enclosed by a Teflon jacket both inside and out.
 - 1. Inner jacketing shall be minimum 17 oz/sq. yd; outer jacketing shall be minimum 18 oz/sq. yd.
 - 2. Provide side gussets of minimum 18 oz/sq. yd. Teflon coated fiberglass cloth.
 - 3. Insulation core shall be type "E" fiberglass mat, no binders.
 - 4. Jacket shall be of a double sewn construction with a silicone/Teflon fiberglass belting system with stainless steel double "D" rings.
 - 5. Jacket shall be suitable for the service conditions of 400 degrees F pipe service conditions for steam piping, and 250 degrees F for steam condensate piping.
- B. Jackets shall be as manufactured by Alpha Associates, Inc., Advance Thermal Corp., or BWI Distribution, Inc

2.15 TAPES

- A. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
- B. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.
 - 1. Products:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 - 2. Width: 3 inches.
 - 3. Thickness: 11.5 mils.
 - 4. Adhesion: 90 ounces force/inch in width.
 - 5. Elongation: 2 percent.
 - 6. Tensile Strength: 40 lbf/inch in width.
 - 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- C. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136 and UL listed.
 - 1. Products:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - b. Compac Corp.; 110 and 111.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
 - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
 - 2. Width: 3 inches.
 - 3. Thickness: 6.5 mils.
 - 4. Adhesion: 90 ounces force/inch in width.
 - 5. Elongation: 2 percent.
 - 6. Tensile Strength: 40 lbf/inch in width.
 - 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

- D. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.
- E. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.
1. Products:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - b. Compac Corp.; 120.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
 - d. Venture Tape; 3520 CW.
 2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34 lbf/inch in width.

2.16 SECUREMENTS

- A. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
- B. Bands:
1. Products:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 316; 0.015 inch thick, 3/4 inch wide with wing or closed seal.
 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.
- C. Insulation Pins and Hangers:
1. 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.
 - a. Products:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; CD.
 - 3) Midwest Fasteners, Inc.; CD.
 - 4) Nelson Stud Welding; TPA, TPC, and TPS.
 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.
 - a. Products:
 - 1) AGM Industries, Inc.; CWP-1.

- 2) GEMCO; Cupped Head Weld Pin.
 - 3) Midwest Fasteners, Inc.; Cupped Head.
 - 4) Nelson Stud Welding; CHP.
 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. Comply with the following requirements:
 - a. Products:
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - d. 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. Comply with the following requirements:
 - a. Products:
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- D. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- E. Wire: 0.062-inch soft-annealed, stainless steel.
 1. Manufacturers:
 - a. ACS Industries, Inc.
 - b. C & F Wire.
 - c. Childers Products.
 - d. PABCO Metals Corporation.
 - e. RPR Products, Inc.

2.17 CORNER ANGLES

- A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- B. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation 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.
 - 3. 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. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 COMMON INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system 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. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.

- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Install insulation continuously through hangers and around anchor attachments.
- K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at 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 ends 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.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. 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 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. 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.
- Q. Replace insulation on existing piping, ductwork and equipment where indicated on the drawings. Match insulation type and thickness indicated by the insulation schedule at the end of this section.
- R. Replace insulation on new and existing piping, ductwork and equipment where insulation is damaged during construction or removed for testing and balancing work.

- S. 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.
 7. Unions.
 8. Heating water strainers (1-inch and less).
 9. Flanges
 10. Expansion joints.
 11. Heating water valves (1-inch and less).

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
- F. Insulation Installation at Floor Penetrations:
1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves

and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.

2. Pipe: Install insulation continuously through floor penetrations.

3.5 DUCT AND PLENUM INSULATION INSTALLATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Protect exposed corners with secured corner angles.
 4. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

3.6 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. 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 ends 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 removable, re-useable metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Covers for split case pumps shall be constructed with insulated housing in two sections with upper section removable for access to casing. 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 aluminum 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.

3.7 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Provide non-compressible inserts at hanger and support locations for pipes 4" and larger.
- E. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.8 CELLULAR-GLASS INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of cellular-glass insulation to valve body.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.

3.9 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- 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.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.10 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

- E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. 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.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

- a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. 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.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.11 POLYISOCYANURATE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.

- C. Insulation Installation on Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed sections of polyisocyanurate insulation to valve body.
 - 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.

3.12 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.
 - 1. 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. Duct Sound Lagging:
 - 1. Seal and fasten in accordance with manufacturer's written instructions to maintain specified STC rating.
 - 2. Overlap duct lagging minimum 2-inches at seams.
 - 3. Do not compress insulation to solid.

3.13 REMOVABLE, REUSABLE INSULATION JACKETS

- A. Install removable, reusable insulation jackets for all piping, fittings, valves, and other items of the steam pressure reducing station.
- B. Install removable, reusable insulation jackets for valves, traps and flow meters for high pressure steam and condensate piping systems.

3.14 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous UL-listed fire rating.
- B. Install as a fully encapsulated, two-layer system applied directly to the duct surface. Provide a 3-inch overlap between seams of the twolayers.
- C. Utilize banding attachment on ducts less than 24 inches in width. Utilize carbon or stainless steel bands.
- D. Insulate duct access panels and doors to achieve same fire rating as duct.

3.15 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Refer to Division 9 painting Sections.
- 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.

3.16 ACOUSTICAL JACKETS

- A. Apply acoustical jacketing to air terminal units and laboratory air terminal units located exposed or above ceilings within classrooms, chemistry labs, tutorial area, study, and similar acoustically sensitive spaces. Jacketing to extend minimum 6" beyond terminal unit, each side.
- B. Apply acoustical jacketing to open-ended ductwork located exposed or above ceilings within classrooms, chemistry labs, tutorial area, study, and similar acoustically sensitive spaces. Jacketing to extend minimum 10-feet beyond open-ended ductwork, or duct-through-wall penetration.

3.17 INSULATION APPLICATION SCHEDULE

- A. Acceptable insulation materials, thickness and vapor retarder requirements are identified for each application and size range. If more than one material is listed for an application and size range, selection from the materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Below-grade piping.
 - 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
 - 3. Exhaust ductwork.
 - 4. Factory-insulated flexible ducts.
 - 5. Factory-insulated plenums and casings.
 - 6. Flexible connectors.
 - 7. Vibration-control devices.
 - 8. Factory-insulated access panels and doors.

- C. Where metal ducts are specified to have internal duct liner, the thickness of the external insulation may be reduced by one inch.
- D. Provide removable, replaceable insulation plugs at manufacturer's equipment identification plates and at ASME pressure vessel plates on insulated equipment.

SERVICE	INSULATION MATERIAL	INSULATION THICKNESS	VAPOR RETARDER REQUIRED
DOMESTIC HOT AND RECIRCULATED HOT WATER PIPING			
Indoor Duty:			
1" diameter and smaller	Mineral Fiber	1"	No
1" diameter and smaller, Alternative Insulation Materials	Flexible Elastomeric; or Polyisocyanurate	1"	No
1¼" diameter and larger	Mineral Fiber	1½"	No
1¼" diameter and larger, Alternative Insulation Materials	Flexible Elastomeric; or Polyisocyanurate	1½"	No
Unconditioned Indoor Space: (Note 1)			
All sizes	Mineral Fiber or Cellular Glass	1-1/2"	No
DOMESTIC COLD WATER PIPING INCLUDING TEPID WATER, NON-POTABLE MAKEUP WATER, TRAP PRIMING LINE, ETC.			
General Indoor Duty:			
1" diameter and smaller	Mineral Fiber; Flexible Elastomeric; or Polyisocyanurate	1"	Yes
1¼" diameter and larger	Mineral Fiber; or Flexible Elastomeric	1½"	Yes
1¼" diameter and larger, Alternative Insulation Material	Polyisocyanurate	1½"	Yes
Unconditioned Indoor Space: (Note 1)			
All sizes	Mineral Fiber or Cellular Glass	1-1/2"	Yes
AIR CONDITIONING CONDENSATE DRAIN, & EQUIPMENT DRAIN PIPING			
1-1/2" diameter and smaller	Flexible Elastomeric	3/4"	Yes
2" diameter and larger	Flexible Elastomeric	1"	Yes
FLOOR DRAINS, TRAPS AND DRAIN PIPING WITHIN 10 FEET OF DRAIN RECEIVING CONDENSATE AND EQUIPMENT DRAIN WATER BELOW 60 DEGREES F			
All sizes	Mineral Fiber	1"	Yes
All sizes, Alternative Insulation Material	Flexible Elastomeric	1"	Yes
EXPOSED SANITARY DRAINS AND DOMESTIC WATER SUPPLIES AND STOPS FOR FIXTURES FOR THE DISABLED			
Refer to Division 22 Sections			

SERVICE	INSULATION MATERIAL	INSULATION THICKNESS	VAPOR RETARDER REQUIRED
INDOOR CHILLED WATER			
Indoor Duty:			
1¼" diameter and smaller	Mineral Fiber; or Flexible Elastomeric; or Polyisocyanurate	1/2"	Yes
1½" diameter and larger	Mineral Fiber	1"	Yes
1½" diameter and larger, Alternative Insulation Material	Cellular Glass	1-1/2"	Yes
1½" diameter and larger, Alternative Insulation Material	Flexible Elastomeric	1"	Yes
1½" diameter and larger, Alternative Insulation Material	Polyisocyanurate	1"	Yes
Unconditioned Indoor Space: (Note 1)			
2" diameter and smaller	Mineral Fiber or Cellular Glass	1-1/2"	Yes
2½" diameter and larger	Mineral Fiber or Cellular Glass	2"	Yes
INDOOR REFRIGERANT SUCTION AND HOT GAS PIPING			
Generally, All sizes	Flexible Elastomeric	1/2"	Yes
Unconditioned Space (Note 1), All Sizes	Flexible Elastomeric	1"	Yes
OUTDOOR ABOVEGROUND REFRIGERANT SUCTION AND HOT GAS PIPING			
All sizes	Cellular Glass	1-1/2"	Yes
HEATING HOT WATER SUPPLY AND RETURN PIPING			
Indoor Duty:			
3" diameter and smaller	Mineral Fiber; or Flexible Elastomeric	1"	No
3" diameter and smaller, Alternative Insulation Material	Polyisocyanurate	3/4"	No
Unconditioned Indoor Space: (Note 1)			
All sizes	Mineral Fiber or Cellular Glass	1-1/2"	No
SUPPLY-AIR DUCTS AND PLENUMS			
Indoor Duty			
Concealed (any height) or exposed greater than 10 feet above floor, Generally	Mineral-Fiber Blanket	1-1/2"	Yes
Exposed within 10 feet of floor, Generally	Mineral-Fiber Board	1-1/2"	Yes
Attic Spaces and unconditioned space within 10 feet of floor (Note 1)	Mineral-Fiber Board	1-1/2"	Yes

SERVICE	INSULATION MATERIAL	INSULATION THICKNESS	VAPOR RETARDER REQUIRED
Attic Spaces and unconditioned space greater than 10 feet above floor	Mineral-Fiber Blanket	1-1/2"	Yes
Supply Ducts for AHU-1	None	--	--
Supply Ducts for Heating Only Duty	None	--	--
RETURN-AIR DUCTS AND PLENUMS			
Indoor Duty			
In locations other than attics and unconditioned space	None	--	--
Attic Spaces and unconditioned space within 10 feet of floor (Note 1)	Mineral-Fiber Board	1"	Yes
Attic Spaces and unconditioned space greater than 10 feet above floor	Mineral-Fiber Blanket	1"	Yes
OUTSIDE-AIR DUCTS AND PLENUMS			
Indoor Duty			
Concealed (any height) or exposed greater than 10 feet above floor	Mineral-Fiber Blanket	1-1/2"	Yes
Exposed within 10 feet of floor	Mineral-Fiber Board	1-1/2"	Yes
Attic Spaces and unconditioned space within 10 feet of floor	Mineral-Fiber Board	1-1/2"	Yes
Attic Spaces and unconditioned space greater than 10 feet above floor	Mineral-Fiber Blanket	1-1/2"	Yes
HEAT EXCHANGER	Flexible Elastomeric; or Mineral Fiber Board; or Mineral Fiber Pipe and Tank	1-1/2"	Yes
CHILLED WATER PUMP	Mineral Fiber Board	2"	Yes
HEATING HOT WATER PUMP	Mineral Fiber Board	2"	No
DOMESTIC HOT WATER RECIRCULATING PUMP	Flexible Elastomeric; or Mineral Fiber Board; or Mineral Fiber Pipe and Tank	1"	No
EXPANSION/COMPRESSION TANKS AND HYDROPNEUMATIC TANKS (FOR COLD SERVICES)	Flexible Elastomeric; or Mineral Fiber Board; or Mineral Fiber Pipe and Tank	1"	Yes
EXPANSION/COMPRESSION TANKS (FOR HOT SERVICES)	Mineral Fiber Board; or Mineral Fiber Pipe and Tank	2"	No

SERVICE	INSULATION MATERIAL	INSULATION THICKNESS	VAPOR RETARDER REQUIRED
AIR SEPARATORS AND OTHER VESSELS FOR COLD SERVICES	Flexible Elastomeric; or Mineral Fiber Board; or Mineral Fiber Pipe and Tank	2"	Yes
AIR SEPARATORS AND OTHER VESSELS FOR HOT SERVICES	Mineral Fiber Board; or Mineral Fiber Pipe and Tank	2"	No
PIPING SYSTEM SIDE-STREAM FILTER HOUSING AND SHOT FEEDERS – COOLING DUTY	Mineral Fiber Board; or Mineral Fiber Pipe and Tank	1-1/2"	Yes

Notes:

1. Unconditioned spaces include the basement mechanical rooms, penthouse mechanical rooms, attics spaces, and other locations where the summer temperature and humidity conditions may be similar to outdoor conditions.
2. Where rigid pipe insulation (cellular glass, etc.) is scheduled, provide mineral fiber through and 6 inches beyond pipe sleeves to allow for pipe expansion.
3. Refer to Part 3 specification section titled "Equipment, Tank, and Vessel Insulation Installation" for requirements for removable, re-usable metal boxes lined with insulation at pumps.

3.18 FIELD APPLIED JACKET APPLICATION SCHEDULE

SERVICE	FIELD APPLIED JACKET TYPE
Indoor, exposed insulated piping within 10 feet of floor, for service temperatures 200 degrees F and below	PVC
Indoor concealed piping and exposed insulated piping greater than 10 feet above floor	None
Outdoor exposed piping	Self-Adhesive Outdoor Jacket
Indoor, All Locations, Fittings and valves in piping systems at service temperatures 200 degrees F and below	Factory Fabricated PVC covers
Outdoor, all locations, fittings and valves in piping systems	Aluminum
Indoor, exposed insulated ductwork within 10 feet of floor	Woven Glass Fiber Fabric
Indoor concealed insulated ductwork and exposed insulated ductwork greater than 10 feet above floor	None
Indoor, exposed sanitary drains and domestic water supplies and stops for fixtures for the disabled	Refer to Division 22 Sections
Outdoor exposed ducts	Self-Adhesive Outdoor Jacket
Equipment, generally (Notes 1 & 2)	Woven Glass Fiber Fabric
Equipment, cold surface (Notes 1 & 2)	PVC
Equipment for service temperatures above 200 degrees F, generally (Note 3)	Aluminum Jacket

Notes:

1. Refer to Part 3 specification section titled "Equipment, Tank, and Vessel Insulation Installation" for requirements for removable, re-usable metal boxes lined with insulation at pumps.

2. Including factory insulated equipment without factory applied jacket.

END OF SECTION

SECTION 23 0900

INSTRUMENTATION AND CONTROL FOR HVAC

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. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Related Sections include the following:
 - 1. Section 23 0519 "Meters and Gages for Mechanical Piping" for thermometers, gages, and thermowells.
 - 2. Section 23 8219 "Fan Coil Units" for fan coil units to have factory installed controllers, control valves, and sensors furnished under this Section.
 - 3. Section 23 0901 "Air Measuring Stations" for air measuring stations and static pressure stations to be furnished under this section, installed under Section 23 3113 "Metal Ducts"
 - 4. Section 28 3111 "Digital, Addressable Fire Alarm System" for fire and smoke detectors mounted in HVAC systems and equipment.
 - 5. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - a. Section 01 9113 "General Commissioning Requirements".

1.3 DEFINITIONS

- A. Beneficial Use: Owner's operators are able to use the system and receive reliable information in their normal work schedules for inputs and outputs in the automation system network.
- B. BAS: Building Automation System
- C. DCP: Digital control panel.
- D. DC: Direct-digital controls.
- E. DPDT: Double-pole, double-throw.
- F. DPST: Double-pole, single-throw.
- G. LAN: Local area network.
- H. FMS: Facility Monitoring SystemMS/TP: Master-slave/token-passing.
- I. PICS: Protocol Implementation Conformance Statement.
- J. SPDT: Single-pole, double-throw.

K. SPST: Single-pole, single-throw.

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Water Temperature: Plus or minus 1 deg F.
 - b. Water Pressure: Plus or minus 2 percent of full scale.
 - c. Space Temperature: Plus or minus 1 deg F.
 - d. Ducted Air Temperature: Plus or minus 1 deg F.
 - e. Outside Air Temperature: Plus or minus 2 deg F.
 - f. Dew Point Temperature: Plus or minus 3 deg F.
 - g. Temperature Differential: Plus or minus 0.25 deg F.
 - h. Relative Humidity: Plus or minus 5 percent.
 - i. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - j. Airflow (Terminal): Plus or minus 10 percent of full scale.
 - k. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
 - l. Carbon Dioxide: Plus or minus 50 ppm.
 - m. Electrical: Plus or minus 5 percent of reading.

1.5 SYSTEM DESCRIPTION

- A. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems.
- B. Operator workstations permit interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- C. System shall be an extension of the existing Goucher College Campus Control and Monitoring System.
- D. System shall include BACnet DDC protocol and connectivity to allow network connections for BAS network.

- E. System Architecture:
 - 1. Minimum one primary controller with adequate resources and memory for input and output points to be trended on 1 minute intervals.
 - 2. Provide a single controller for each piece of main equipment (AHU, Chiller Plant, etc.) that operates on a peer-to-peer network.
 - 3. Terminal controllers (VAV boxes, etc.) may reside on polling or peer-to-peer secondary network with maximum nodes and specified time response.

1.6 SUBMITTALS

- A. System Interoperability Certification: Submit documentation that certifies proven capability of the new system to interface with the existing DDC System. Documentation shall provide a technical explanation of the system, and its ability to be part of a future campus building automation system upgrade.
- B. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - 1. Each control device labeled with setting or adjustable range of control.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 - 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 - 3. Details of control panel faces, including controls, instruments, and labeling.
 - 4. Written description of sequence of operation.
 - 5. Schedule of dampers including size, leakage, pressure drop, and flow characteristics.
 - 6. Schedule of valves including size, leakage, pressure drop, and flow characteristics.
 - 7. Trunk cable schematic showing programmable control unit locations and trunk data conductors.
 - 8. Listing of connected data points, including connected control unit and input device.
 - 9. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
 - 10. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 - 11. Settings of control devices.
 - 12. Lists of proposed devices and equipment for each system drawing.
 - 13. Calculations for sizing valves, dampers, and actuators.
 - 14. Floor plans indicating locations of zone sensors.
- D. Data Communications Protocol Certificates (one of the following):
 - 1. Certify that each proposed DDC system component complies with ASHRAE 135 (BACNet).
- E. Samples: For each color required, of each type of thermostat cover.

- F. Software and Firmware Operational Documentation: Include the following:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
 - 5. Software license required by and installed for DDC workstations and control systems.
 - G. Software Upgrade Kit: For Owner to use in modifying software to suit future power system revisions or monitoring and control revisions.
 - H. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
 - I. Maintenance Data: For systems to include in maintenance manuals specified in Division 01. Include the following:
 - 1. Maintenance instructions and lists of spare parts for each type of control device.
 - 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 - 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - 5. Calibration records and list of set points.
 - 6. Start-up, normal, and emergency operating procedures.
 - 7. Names, addresses, and phone numbers of equipment suppliers, subcontractors, and manufacturer's field representatives.
 - 8. List of parts required for one year of continuous operation. Include parts numbers and names, addresses, and phone numbers of supply sources.
 - J. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
 - K. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences. Provide DCP data file construction including point processing assignments, physical terminal relationships, scales and offsets, command and alarm limits, etc.
 - L. Documentation of instruments and sensors field calibration.
 - M. LEED Submittals:
 - 1. Credit EQ 1: Manufacturers' product data and shop drawings for carbon dioxide monitoring system.
 - 2. Credit EQ 3.2: Building air flush-out procedures.
- 1.7 QUALITY ASSURANCE
- A. Installer Qualifications: An experienced installer who is an authorized representative of the automatic control system manufacturer for both installation and maintenance of units required for this Project.
 - B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.

- 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 90A, "Installation of Air Conditioning and Ventilation Systems."
- E. Comply with ASHRAE 135 or LonWorks for DDC system control components.
- F. Comply with ANSI B16.104, "Quality Control Standard for Control Valve Seat Leakage."

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.9 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
 - 1. Self-timers for mechanical systems shall not be located in noise critical spaces.
- B. Coordinate equipment with Section 28 3111 "Digital Addressable Fire Alarm System" to achieve compatibility with equipment that interfaces with that system.
- C. Coordinate supply of conditioned electrical circuits for control units and operator workstation.
- D. Coordinate equipment with Section 26 2416 "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- E. Coordinate equipment with Section 23 2923 "'Variable Frequency Motor Controllers" to achieve compatibility with motor starters and annunciation devices.
- F. Coordination with Commissioning Agent:
 - 1. Attend a sequence coordination meeting with engineer, CxA, and contractors to review sequences before software programming.
 - 2. Furnish a full operational graphic interface (laptop) for use at the new building prior to commissioning. This may be the Mobile Operator Station.
 - 3. ATC Contractor shall provide a minimum of one dedicated controls technician during the functional performance testing of all building systems controlled, monitored or interfaced with the ATC system. This individual shall be familiar with the programming and control sequences. During the functional testing period this technician shall have no other assigned responsibilities except to work with the Commissioning Agent.
 - 4. Should the technician assigned to work with the Commissioning Agent not be available at the time of testing of a system or piece of equipment, the ATC Contractor shall provide a substitute technician of equal qualifications to work during this period.
 - 5. ATC Contractor shall be responsible for any and all costs incurred by other parties due to the non-availability of a qualified technician.

1.10 WARRANTY

- A. Special Warranty: During the warranty period the entire system shall be kept in proper operating condition and serviced at no additional cost to the Owner.

- B. Special Warranty: Corrective software modifications made during warranty service periods shall be updated on user documentation and on user and manufacturer archived software disks.

1.11 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Replacement Materials: One replacement relay mechanism for each unique damper motor, valve motor, thermostat, and positioning relay.
- C. Maintenance Materials: One set of any special tools required for operation, adjustment, resetting, or maintenance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Control Systems Components: As indicated in product articles.
 2. Electric, Electronic, and DDC Systems:
 - a. Automated Logic Corporation.
 - b. Johnson Controls.
 - c. Schneider Electric.
 - d. Siemens.

2.2 DDC EQUIPMENT

- A. Mobile Operator Station: Provide two portable terminals (laptop computers) with all software for building automation pre-loaded. Units shall be Windows 8 compatible laptop computer, with Intel Core i3 processor, minimum system RAM memory of 4 GB, minimum cache memory of 2 GB, minimum 500 GB hard drive, integral 802.11b/g/n WLAN, and three USB 2.0 ports.
- B. Provide DDC server and server software for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft Data Engine (MSDE) or Microsoft SQL. The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in either Microsoft Access or SQL database format.
- C. Provide UPS power and manual bypass switch for DDC control panels.
- D. Application Software: Include the following:
 1. Input/output capability from operator station.
 2. Operator system access levels via software password.
 3. Database creation and support.
 4. Dynamic Color Graphic Displays: Color graphic floor plan displays, and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems, and hot water systems, shall be provided as noted by the I/O Summary Sheets specified in Section 23 0993 "Sequence of Operations for HVAC Controls". Points in the system shall be included in at least one dynamic graphic.

- a. System Selection/Penetration: The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands.
 - b. Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.
 - c. Windowing: The windowing environment of the PC Operator Workstation shall allow the user to simultaneously view several graphics at the same time to analyze total building operation, or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
 - d. VAV Summary Graphic: Tabular information of VAV's per AHU, including setpoints, room temperature, discharge temperature, damper position, airflow, reheat valve position, etc.
5. Alarm processing.
 6. Event Processing: Detection and accommodation of single or multiple failures of either workstations, DDC panels or the network media. The network shall include provisions for automatically re-configuring itself to allow operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.
 7. Automatic restart of field equipment on restoration of power.
 8. Data Collection:
 - a. Message and alarm buffering to prevent information from being lost.
 - b. Error detection, correction, and re-transmission to guarantee data integrity.
 - c. Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.
 - d. Extensive archiving of system configuration data, historical data, trend data, and operator actions. All data stored shall be through the use of a standard database platform.
 - e. Trend and change of value data shall be stored with a network DDC engine and uploaded with a dedicated trend database or exported in a selectable data format via provided data export utility.
 9. Graphic Development on Workstation: Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.
 - a. The ATC System contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols.
 - b. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following: define symbols; position and size symbols; define background screens; define connecting lines and curves; locate, orient and size descriptive text; define and display colors for all elements; and establish correlation between symbols or text and associated system points or other displays.
 - c. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aids the operator in the analysis of the facility. To accomplish this, the user shall be able to build graphic displays that include point data from multiple DDC panels, including application specific controllers. Graphical displays shall include, but not be limited to, the following:

- 1) Floor Plan requirements:
 - a) Major equipment locations
 - b) Room temperatures
 - c) Room RH% levels
 - d) Fire damper locations and positions
 - e) Combination fire and smoke damper locations and positions
 - f) Lighting systems – all available info from the lighting control system, including scene number, lighting lumens, trouble, etc.
 - 2) System Schematic requirements:
 - a) Air Handling Units (including BTUH calcs for various AHU components)
 - b) Exhaust Fans and systems (including BTUH calcs for various energy recovery components)
 - c) Chilled Water System
 - d) Heating Hot Water System
 - e) Domestic Water System (including solar hot water system)
 - f) Fan Coil Units
 - g) Sump Pumps
 - h) Elevator Sump Pumps
 - 3) Generally, if equipment/systems are operating normally, they shall appear in a green color. If an alarm condition is present, the equipment/system shall appear in a red color.
10. Maintenance management – suggested equipment maintenance schedules, user-input equipment maintenance schedules, etc.
- E. Control Units: Modular, multi-tasking, multi-user, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup UPS power source.
1. Units monitor or control each input/output point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator station.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse input/output.
 - c. Monitoring, controlling, or addressing data points.
 - d. Testing and developing control algorithms without disrupting field hardware and controlled environment.
 - e. Control processes.
 - f. Energy Management Applications.
 - g. Alarm Management.
 - h. Historical/Trend Data for points.
 - i. Maintenance Support Applications.
 - j. Custom Processes.
 - k. Operator I/O
 - l. Dial-Up Communications.
 - m. Manual Override Monitoring.
 3. Point Types: Support the following types of point inputs and outputs without the addition of equipment outside the DDC panel:
 - a. Digital Inputs for status/alarm contacts: Dry contract closure, pulse accumulator, and voltage sensing.
 - b. Digital Outputs for on/off equipment control: Contact closure.

- c. Analog Inputs for temperature, pressure, humidity, flow, and position measurements: 4-20 Ma, 0-10 Vdc, Thermistors, and 1000 ohm RTD's.
 - d. Analog Outputs for valve and damper position control, and capacity control of primary equipment: 4-20 mA, 0-10 Vdc, and pulse inputs for pulsed contact monitoring.
 4. Point Quantity: provide adequate points on a single control unit to accomplish the sequences, plus 10% spare capacity for each point type, with minimums as follows:
 - a. Five DI.
 - b. Five DO.
 - c. Two AI.
 - d. Two AO.
 5. Local operator interface provides for download from or upload to mobile operator station: Provide at least two RS-232C serial data communication ports for simultaneous operation of multiple operator I/O devices such as industry standard printers, laptop workstations, PC workstations, and panel mounted or mobile operator station. Standalone DDC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected devices.
 6. Local Status Indicator Lamps: Local status indication for each binary input and output for constant, up-to-date verification of point conditions without the need for an operator I/O device.
 7. Integrated On-Line Diagnostics: Continuously perform self-diagnostics, communication diagnosis and diagnosis of subsidiary equipment. Both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each Control Unit, and shall not require the connection of an operator I/O device.
 8. Surge and Transient Protection: Isolation shall be provided at network terminations, as well as field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.
 9. Powerfail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of Control Units to prevent the loss of database or operating system software. Non-Volatile memory shall be incorporated for critical controller configuration data, and battery back-up shall be provided to support the real-time clock and volatile memory for a minimum of 72 hours. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention. Should memory be lost, the panel will automatically receive a download via the local area network, phone lines, or connected computer. In addition, the user shall have the capability of reloading the Control Unit through the local area network, the local RS-232C port, or telephone line dial-in.
- F. Local Control Units: Modular, multi-tasking, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
 1. Units monitor or control each input/output point; process information; and download from or upload to operator station, PC, mobile operator station, or DDC panel in the network.
 2. Units shall be able to extend performance and capacity through the use of remote Local Control Units.
 3. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse input/output.
 - c. Monitoring, controlling, or addressing data points.
 - d. Control processes.

- e. Energy management applications.
 - f. Operator I/O.
 4. Local operator interface provides for download from or upload to mobile operator station.
 5. Units shall directly support the use of mobile operator station. The capabilities of the portable terminal shall include but not be limited to the following:
 - a. Display temperatures.
 - b. Display status.
 - c. Display setpoints.
 - d. Display control parameters.
 - e. Override binary output control.
 - f. Override analog setpoints.
 - g. Modification of gain and offset constants.
 6. Power fail Protection: System setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.
 7. Application: AHU Controllers:
 - a. AHU Controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in the Execution portion of this specification, and for future expansion: Large Air Handling Units with variable speed fan arrays, chilled water cooling coils, and hot water heating coils; Mixed Air-Single Duct; and 100% Outside Air Single Duct.
 - b. AHU Controllers shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally standalone fashion.
 - c. AHU controllers shall have a library of control routines and program logic to perform the sequence of operation as required by the I/O Summary Sheets in this specification.
 - d. Occupancy-Based Standby/Comfort Mode Control: Each AHU Controller shall have a provision for occupancy sensing overrides. Based upon the contact status of either a manual wall switch or an occupancy sensing device, the AHU Controller shall automatically select either Standby or Comfort mode to minimize the heating and cooling requirements while satisfying comfort conditions.
 - e. Continuous Zone Temperature Histories: Each AHU Controller shall have the capability to automatically and continuously, maintain a history of the associated zone temperature to allow users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of two samples per hour shall be stored.
 - f. Alarm Management: Each AHU Controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.
- G. Variable Air Volume and Constant Volume Air Terminal Unit Controller/Damper Actuator Assembly (VMA): Provide for each air terminal unit (variable volume or constant volume supply), configurable, application specific DDC controller with integral pressure transducer and damper actuator (VMA) to perform the sequence of control described on the drawings for pressure-independent application and to provide monitoring and control functions listed in the I/O summary sheets at the end of Section 23 0993 "Sequence of Operations for HVAC Controls."
 1. Controllers/Actuators shall be electronic type, furnished under this Section, and shipped to the terminal unit manufacturer (specified under Section 23 3600 "Air Terminal Units" for factory mounting.
 2. The VMA shall provide both standalone and networked direct digital control:

- a. Ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.
- b. Control setpoint changes initiated over the network shall be written to VMA non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.
3. Components shall be connected and mounted as a single assembly that can be removed as one piece.
4. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 30 seconds for quick damper positioning.
5. The VMA shall determine airflow by dynamic pressure measurement using an integral dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters.
6. Automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
7. Utilize a proportional plus integration (PI) algorithm for the space temperature control loops.
8. Continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle.
9. Provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
10. Interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.
11. Capable of direct electronic connection to the Alnor® DB150 Balometer™ balancing hood. Connection shall be through a port located on the room sensor. As an alternative, software balancing tools shall be provided that will run in a hand-held Personal Computer (such as the Apple Ipad or Android device). The balancing tools shall allow adjustment of airflow and temperature setpoints and parameters and provide permanent upload of the values entered to the VMA. The handheld device shall connect to the terminal unit through the room sensor port.
12. Performance shall be self-documenting via on-board diagnostics. Diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance.
13. Detect system error conditions to assist in managing the VAV zones.
14. Provide a flow test function to view damper position vs. flow in a graphical format. The information shall alert the user to check damper position. Provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.
15. Compatible with demand-based static pressure reset down to 2/3 of duct static pressure set point.
16. Inputs:
 - a. Analog inputs with user-defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet: 0-10 VDC Sensors, 1000ohm RTDs, and NTC Thermistors.
 - b. Binary inputs shall monitor dry contact closures
 - c. Sideloop application for humidity control and monitoring.
17. Outputs
 - a. Analog outputs shall provide the following control outputs: 0-10 VDC
 - b. Binary outputs shall provide a SPST output rated for 500mA at 24 VAC.
18. Sensor Support: Space sensors specified herein, space sensors as defined by analog input requirements, carbon dioxide sensors, and humidity sensors defined by the AI sideloop.

19. Controller shall accurately control air flow quantity with a differential pressure signal of 0.03 inch wg.
- H. LAN: DDC system shall tap into existing University Intranet.
- I. Software: Update to latest version of software at Project completion. Include and implement the following capabilities from the control units:
1. Units of Measure: Inch-pound and SI (metric).
 2. Control Algorithms: Pre-tested two position control, proportional control, proportional plus integral control, and proportional, integral, plus derivative control.
 3. Load Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, DDC with fine tuning, calendar based scheduling, holiday scheduling, temporary schedule overrides, and trend logging.
 4. HVAC Control Programs: Optimal run time, supply-air reset, fan speed/CFM control, heating/cooling interlock, hot water reset, supply air temperature reset, duct static pressure reset, and enthalpy switchover.
 - a. Programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow operator customization.
 5. Chiller Control Programs: Control function of condenser water reset, chilled-water reset, and equipment sequencing.
 6. Programming Application Features: Include trend point, alarm messages, weekly scheduling, and interlocking.
- J. Data Control:
1. Provide all hardware devices required to be connected to the remote electronic panels, and the standard control software modules to be implemented. In addition, additional hardware and software required to accomplish the detailed sequence of operations specified shall be provided. The following also includes pseudo points required to be provided for display in logical groups and graphics. Commandable pseudo points shall be commandable directly from displays.
 2. Each analog point shall have unique remote panel resident dual high and dual low limit alarm thresholds. Where specified, floating (a band above and below a setpoint) alarm limits shall be provided.
 3. Each digital output shall have a software-associated monitored input. Any time the monitored input does not track it's associated command output within a programmable time interval, a "command failed" alarm shall be reported.
 4. Where calculated points such as CFM are shown, they shall appear in their respective logical groups. The respective unconditioned raw data (such as the logarithmic differential pressure) points shall also be grouped in a special group for display and observation independent of the logical groups.
 5. Unless otherwise specified or approved prior to bidding, the primary analog input and the analog output of each DDC loop shall be resident in a single remote panel containing the DDC algorithm, and shall function independent of any peer or mux communication links. Secondary (reset type) analog inputs may be received from the peer network, but approved default values and/or procedures shall be substituted in the DDC algorithm for this secondary input if network communications fail or if the secondary input becomes erroneous or invalid.

2.3 CONTROL PANELS

- A. Central (Master) Control Panels: Fully enclosed, steel-rack-type cabinet with locking doors or locking removable backs. Match finish of panels and provide multicolor graphic displays, schematically showing system being controlled.

- B. Local Control Panels: Unitized cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.
 - 1. Fabricate panels of 0.06-inch- thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
 - 2. Panel-Mounted Equipment: Temperature and humidity controllers, relays, and automatic switches; except safety devices. Mount devices with adjustments accessible through front of panel.
 - 3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
 - 4. Graphics: Color-coded graphic, laminated-plastic displays on doors, schematically showing system being controlled, with protective, clear plastic sheet bonded to entire door.
 - 5. Isolate low voltage and line voltage terminals.

2.4 ANALOG CONTROLLERS

- A. Fan Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

2.5 SENSORS

- A. Electronic Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
 - 1. Thermistor Temperature Sensors: 10,000 ohm at 77 deg F; lead wires terminated on enclosed terminal block.
 - a. Accuracy: Plus or minus 0.4 deg F from 0 to 70 deg F.
 - b. Wire: Twisted, shielded-pair cable.
 - c. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. Do not use insertion sensors where sensor is less than 72-inches downstream of heating or cooling coils.
 - d. Averaging Elements in Ducts: Minimum 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required. Averaging sensors shall be used where sensors are installed within 72-inches downstream of heating or cooling coils.
 - e. Insertion Elements for Liquids: Minimum insertion length of 2-1/2 inches, stainless steel well.
 - f. Room Sensors: Locking cover; element terminated on clamp type connectors or plug-in strip; plug-in communications jack, insulated base for mounting on exterior walls.
 - 1) For room sensors in offices and conference rooms provide sensors with push button for over-ride of unoccupied functions; display of space temperature and setpoint; and occupant temperature setpoint adjustment.
 - 2) For room sensors in classrooms, laboratories, and instructional area, provide only push button for over-ride of unoccupied functions
 - 3) For room sensors in all other spaces, room sensors shall have no additional features, other than sensing space temperature.
 - g. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 - 2. Resistance Temperature Detectors (RTD): Platinum, lead wires terminated on enclosed terminal block.

- a. Accuracy: Plus or minus 0.4 deg F of range (20 deg F to 120 deg F or 70 deg F to 220 deg F).
 - b. Wire: Twisted, shielded-pair cable.
 - c. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. Do not use insertion sensors where sensor is less than 72-inches downstream of heating or cooling coils.
 - d. Averaging Elements in Ducts: Minimum 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required. Averaging sensors shall be used where sensors are installed within 72-inches downstream of heating or cooling coils.
 - e. Insertion Elements for Liquids: Minimum insertion length of 2-1/2 inches, stainless steel well.
 - f. Room Sensors: Match room thermostats cover construction, locking cover; element terminated on clamp type connectors or plug-in strip; push button for override of unoccupied functions, where indicated; plug-in communications jack.
 - g. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
3. Temperature Transmitters: Utilize RTD elements, and shall output a 4-20 mA or 0-10 VDC linear signal over the specified range. Zero point and span shall be adjustable over a minimum of 75 percent of range.
- a. Accuracy: Plus or minus 0.5 percent of span
 - b. Linearity: Plus or minus 0.2 percent of span
 - c. Isolation: Input to output, 600 VDC or A.C. peak
 - d. Housings: Mounted on supply ducts or in non-hazardous spaces shall be NEMA 1:
 - 1) In outdoor air, on outdoor air plenums or intake ducts, or in spaces whose ambient temperature is below 55 deg F, shall be gasketed die-cast aluminum, NEMA 3R minimum.
 - e. Range: Suit the application, and shall be 120 deg F for ducts, 150 deg F for outdoor air sensing, 100 deg F for chilled water and 200 deg F for hot water.
 - f. Transmitters in outdoor air shall be designed to withstand outdoor conditions and be provided with approved sun shields.
 - g. Transmitters shall be the DDC system manufacturer's product compatible with the building automation system.
4. Humidity Sensors and Transmitters: Bulk polymer sensor element; manufactured by Rotronic Instrument Corporation or Vaisala, Inc.
- a. Accuracy: Plus or minus 2 percent for the 0 to 90 percent range and plus or minus 3 percent for the 90 to 100 percent range.
 - b. Wire: Twisted, shielded-pair cable.
 - c. Time Response: 90 percent in 15 seconds.
 - d. Stability: Plus or minus 1 percent RH per year.
 - e. Sensor Temperature Dependence: Plus or minus 0.8 percent additional error at maximum and minimum operating temperatures.
 - f. Calibration: Transmitter shall be capable of relative humidity calibration without disturbing operation, using a single point electronic field calibrator.
 - g. At contractor's option, humidity sensors may be combination type and include space, duct, or outdoor air temperature sensing. The combination sensor to meet the above requirements (including approved manufacturers) while the temperature sensor shall meet the following:
 - 1) Temperature sensor shall have the following characteristics:
 - a) Type: Platinum 1000-ohm RTD.
 - b) Accuracy: Plus or minus 0.4 deg F at 68 deg F.
 - c) Temperature coefficient: Plus or minus 0.009 deg F per deg F.

- d) Range: Suitable for application.
 - h. Output Current: Linear output signal of 4-20mA DC into 500 ohms (minimum) at 24V DC supply.
 - i. Room Sensors: Locking cover matching room thermostats cover construction, span of 20 to 90 percent relative humidity, transmitter temperature range of 23 to 131 deg F.
 - j. Duct Sensors: With mounting plate, range of 0 to 100 percent relative humidity; element length to match specified requirements; NEMA 4 enclosure for electronics; transmitter temperature range of minus 40 to plus 176 deg F.
 - k. Outside-Air Sensors: Range of 0 to 100 percent relative humidity; transmitter temperature range of minus 40 to plus 131 deg F; NEMA 4 enclosure for electronics; transmitter probe shall be mounted in a naturally aspirated solar radiation and precipitation shield.
- 5. Differential Pressure Transmitters - Water: Direct acting for liquid service; diaphragm operated; 5 valve manifold; range suitable for system, minimum 50 percent greater than nominal system working pressure; proportional output 4 to 20 mA; manufactured by Setra or approved equal.
 - a. Accuracy: Plus or minus 0.2 percent of calibrated span
 - b. Hysteresis: 0.05 percent of calibrated span
 - c. Linearity: Plus or minus 0.1 percent of calibrated span
 - d. Damping: Adjustable time constant
 - e. Calibration: Zero point and span adjustable to within 0.5 percent of full span
 - f. Wetted Parts: 316 stainless steel, monel or nickel-chrome carbon steel or aluminum, NEMA 4
 - g. Zero Suppression: 100 percent of span
 - h. Over-range Limit: 200 percent of transmitter range.
 - i. Pipe Connection: Three connections at 120 degree intervals around circumference of pipe, manifolded for improved average sensing accuracy.
- B. Carbon-Dioxide Sensor and Transmitter: Single detectors, using gold-plated non-dispersive infrared optical sensors with automatic baseline correction for self-calibration, suitable over a temperature range of 35 to 120 deg F and humidity range of 0 to 950 percent relative humidity non-condensing, with continuous or averaged reading, 4 to 20 mA output.
 - 1. Measurement range, linear: 0 to 2000 ppm.
 - 2. Accuracy: Plus or minus 1 percent measurement range plus 3 percent of reading.
 - 3. Wire: Twisted, shielded-pair cable.
 - 4. Normal linear output: 4-20 mA.
 - 5. Room Sensors: Locking cover matching room thermostats cover construction.
 - 6. Duct Sensors: With mounting plate, sensor shall be in duct, transmitter shall not require a separate aspiration assembly.
 - 7. Wireless sensor receivers:
 - 8. Outside-Air Sensors: NEMA 4 enclosure, naturally aspirated solar radiation and precipitation shield.
 - 9. Factory written recommendation for calibration shall be never (self-calibrating).
 - 10. Manufacturers: Air Test Technologies, Inc. or approved equal.
 - 11. At Contractor's option carbon dioxide sensors may be the DDC system manufacturer's product, and may be integral with the space temperature sensor housing, provided sensor meets the performance above for the independent units.
- C. Receivers for wireless room sensors: Receiver shall interface with BAS. Sensors shall be FCC approved and shall not interfere with WiFi frequencies. Provide adequate quantity of receivers for coverage of the Atrium. Mount receiver in adjacent accessible space above ceiling, preferably non-public (housekeeping, storage, etc).

- D. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment, for flush mounting. Provide where Division 26 is not providing for lights.
- E. Status Inputs for Electric Motors: Current-sensing relay with current transformers; solid state type, adjustable and set to 175 percent of rated motor current, with the following characteristics:
 - 1. Rating: 0 to 135 amps.
 - 2. Sensor Voltage: Induced from monitored conductor
 - 3. Supply Current: Induced from monitored conductor
 - 4. Isolation: Minimum 600 VAC rms
 - 5. Trip Set Point: Adjustable to $\pm 7\%$ of range
 - 6. Zero Adjustment: None
 - 7. Sealing: NEMA 12
 - 8. Temperature Range: 15°C to 85°C
 - 9. External Current Transformers: For loads exceeding 135 amps.
- F. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- G. Water-Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, SPDT, minimum 7 amp rating resistive at 120 vAC, with appropriate scale range and differential adjustment, with stainless-steel paddle and NEMA 1 enclosure. For ground loop water applications, provide vaporproof type.
- H. Differential Pressure Switches 0" to 10" W.C. - Air: Diaphragm actuated SPDT; minimum rating 5 amps resistive 120 VAC; aluminum or steel NEMA 3R housing; 0.30 inches wg deadband; fully adjustable setpoint over switch range; manual reset snap switch;
 - 1. Diaphragm Material: Silicone rubber or Buna-N.
 - 2. Auxiliary Contacts: To allow duct static pressure switch to be connected to both the DDC system and starter circuit.
 - 3. Manufacturers: Penn or Dwyer Mercoïd.
- I. Differential Pressure Switches - Water: SPDT: Minimum 4 amp inductive rating at 250 VAC; diaphragm or bourdon tube actuated, with adjustable setpoint and maximum switch deadband of 1.5 psi; 150 psi differential working pressure; NEMA 4 housing; manufactured by Penn or Dwyer Mercoïd.
- J. Limit Switches: Minimum rating of 10 amps resistive at 120 VAC; two pole single or double throw; NEMA 3R enclosure; aluminum or stainless steel switch actuation rod; manufactured by Honeywell Micro-Switch, Cutler Hammer, or Allen Bradley.
- K. Damper Blade End Switches: Momentary-type for monitoring the motion of the damper at a prescribed arc of rotation; hermetically sealed mercury type; one or two SPDT contact arrangement as required with current carrying characteristics of 4 amps at 120V AC; manufactured by Dwyer Mercoïd or approved equal.
- L. Float Switch: SPDT contacts, UL recognized, CSA certified, L-bracket mount, equal to Kele model JMP Series.

2.6 THERMOSTATS

- A. Combination Thermostat and Fan Switches: Line-voltage thermostat with two-, three-, or four-position, push-button or lever-operated fan switch.
 - 1. Label switches "FAN ON-OFF," "FAN HIGH-LOW-OFF," "FAN HIGH-MED-LOW-OFF."
Provide unit for mounting on two-gang switch box.
- B. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater.
- C. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual on-off-auto selector switch.
 - 1. Equip thermostats, which control electric heating loads directly, with off position on dial wired to break ungrounded conductors.
 - 2. Dead Band: Maximum 2 deg F.
- D. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature, with copper capillary and bulb, unless otherwise indicated.
 - 1. Bulbs in water lines with separate wells of same material as bulb.
 - 2. Bulbs in air ducts with flanges and shields.
 - 3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit, adequately supported.
 - 4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
 - 5. On-Off Thermostat: With precision snap switches, with electrical ratings required by application.
 - 6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- E. Room Thermostat Cover Construction: Manufacturer's standard locking covers.
 - 1. Set-Point Adjustment: Exposed in offices, concealed elsewhere; adjustment via slide bar.
 - 2. Set-Point Indication: Exposed.
 - 3. Thermometer: None.
 - 4. Material: Plastic.
 - 5. Orientation: Vertical or horizontal.
- F. Room thermostat accessories include the following:
 - 1. Insulating Bases: For thermostats located on exterior walls.
 - 2. Thermostat Guards: Locking, solid metal, ventilated.
 - 3. Adjusting Key: As required for calibration and cover screws.
- G. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
- H. Electric Low-Limit Duct Thermostat (FZ): Snap-acting, single-pole, manual-reset switch in NEMA 1 enclosure that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
 - 1. Bulb Type and Length: Liquid-filled capillary, minimum 20 feet total length and minimum 1 foot length per every 1 square foot of coil area.

2. Quantity: One thermostat for every 20 sq. ft. of coil surface; minimum one per coil section.
3. Range: 30 deg. F to 60 deg F.
4. Electrical Rating: Minimum 2 amps inductive at 240 VAC.
5. Auxiliary Contacts: To allow thermostat to be connected to both the DDC system and starter circuit.
6. Manufacturers: Penn Products or approved equal.

- I. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

2.7 ACTUATORS

A. Sizing:

1. Valves: Size for torque required for valve close-off at maximum pump differential pressure (close-off head).
2. Dampers: Size for required running torque and 120 percent of the required full load opening torque.

B. Electronic Damper Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Coupling: V-bolt and V-shaped, toothed cradle.
2. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
3. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
4. Power Requirements (Two-Position Spring Return): 24-V ac.
5. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
6. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
7. Temperature Rating: Minus 22 to plus 122 deg F.
8. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
9. Run Time: 30 seconds.
10. Electrical Connection: Provide conduit fitting with minimum 3 feet of pre-wired electrical cable.

C. Pressure Independent Control Valve Actuators:

1. Actuator shall be driven by a 24 Vdc motor, and shall accept 2-10 Vdc, 4-20 mA, 3 point floating or pulse width modulation electric signal and shall include resistor to facilitate any of these signals.
2. Fail-Safe Operation: Last Position. The terms "normally closed" and "normally open" shall indicate position of valve when respective controls system is indexed off.
3. Provide external LED readout of current valve position and maximum valve position setting.
4. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
5. Temperature Rating: Minus 22 to plus 122 deg F.
6. Run Time: 30 seconds.
7. Electrical Connection: Provide conduit fitting with minimum 3 feet of pre-wired electrical cable.

D. Electric Butterfly and Ball Valve Control Actuators:

1. Actuators for automatic control valves shall be of the electric, 120 VAC, motor type with a continuous (100%) duty cycle, and be as manufactured by Bray or Belimo.
2. Motor shall be single phase permanent split-capacitor reversing type. Motor insulation shall be Class F or better and shall have built-in thermal overload protector of a bi-metallic strip in the windings set at 338°F with automatic reset. The actuator shall have a self-locking gear-train consisting a (precision-cut) spur gear drive and a worm and worm gear output drive mechanism eliminating the need for a motor brake or brake solenoid. The housing shall be NEMA 4 and the assembly and all components must be UL approved and tagged. The assembly shall include two auxiliary SPDT switches for separated indication of open and closed status. The unit shall include a separate anti-condensation heater/thermostat. The assembly shall have two separate entries for signal and power supply conduits. The housing shall have captive cover screws, a fixed cover seal, and a beacon indicator.
3. Each actuator shall have a manual override handwheel with a power interruption circuit to allow for manual operation or override with or without loss of main power (120VAC) power. Handwheel cannot be power-favored or power-dependent. Power interruption can be accomplished by means of handwheel circuit (other than spring-loaded), local-off-remote control station, or service disconnect separate for each actuator. Mounting and wiring for power interruption circuitry shall be provided and wired by the valve and actuator assembly supplier.
4. Modulating assemblies shall include a servo control board that will accept a 4-20mA DC signal, and retransmit an independent 4-20mA DC signal for confirmation of actuator position. The internal servo control board shall be programmable for reverse-acting, independent opening/closing speeds, signal reversal, and dead-band. The assembly shall be field selectable for loss-of-signal with choices of fail in minimum, maximum, last, or a specific position.

2.8 CONTROL VALVES

- A. General: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
 1. Sizing:
 - a. Generally: 4-psig maximum pressure drop (unless otherwise indicated) at design flow rate.
 - b. Terminal Unit Control Valves: 3-psig maximum pressure drop at design flow rate.
 2. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
 3. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 psig for hydronic systems and 50 psig for steam systems.
- B. Ball Valves NPS 2 and Smaller: Forged brass body with nickel plating, full port stainless steel ball, PTFE seats, 2 EPDM O-rings packing, TEFZEL characterizing disc, 600 psig CWP rating, 500:1 range-ability, brass blow-out proof stainless steel stem, 0 percent leakage, and threaded
- C. Pressure Independent Control Valves (All sizes):
 1. Manufacturers:
 - a. Flow Controls, Model Series "Delta P".
 - b. No substitutions, except sizes 1-1/2" and smaller.
 2. Description: Pressure independent, flow control type. Factory test each control valve to verify flow deviations does not exceed more than $\pm 5\%$ through the operating pressure range. Include calibrated performance tag with each valve, listing the measured flow rate in 10° rotation increments.

3. Rangeability: 100:1 minimum.
 4. Valve Body:
 - a. 2-inch and smaller: Brass.
 - b. 3-inch thru 8-inch: Ductile iron
 - c. Include three factory installed pressure/temperature ports.
 5. Valve Internal Components:
 - a. Construction: Brass, carbon steel, stainless steel or Teflon®. Plastic internal parts are not acceptable.
 - b. Features, 8-inch and smaller: Removable flow characteristic elements, without disrupting connecting piping system.
 - c. Seals, 3-inch and smaller: Removable, without disrupting connecting piping system.
 6. Sizing: 5-psi pressure loss at design flow rate.
- D. Pressure Independent Control Valves (At contractor's option for sizes 1-1/2" and smaller):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Belimo.
 - b. Bell and Gossett.
 - c. Danfoss.
 - d. Flow Control Industries
 2. Control Valve
 - a. Dynamic control valve shall accurately control flow, independent of system pressure fluctuation.
 - b. Valve shall be electronic, modulating 2-way control device.
 - c. Turn down ratio shall be at least 100:1.
 - d. 5-70 PSID differential pressure range.
 - e. Sizing:
 - 1) Design flow rate shall be minimum of 20% greater than flow scheduled on the drawings, for future system capacity in each campus building.
 - 2) 5-psig maximum pressure drop at design flow rate (plus 20%).
 3. Valve Housing:
 - a. For valve size 1/2-inch to 1-1/2-inch: Housing shall be constructed of forged ASTM (CuZn39Pb2) brass rated at no less than 360 psi static pressure and 248 deg. F.
 - b. For valve size 2-inch to 8-inch: Housing shall be constructed of Ductile Iron ASTM A536-65T, Class 60-45-18 rated at no less than 580 psi static pressure and 248 deg. F. Provide ANSI 125 lb flanges for 150 psi body pressure rating.
 4. Flow Regulation Unit:
 - a. Flow regulation unit shall consist of 304 stainless steel and hydrogenated acrylonitrile butadiene rubber (1/2-inch to 1-1/2-inch) or 316 stainless steel and EPDM (2-inch to 6-inch).
 - b. Dual pressure/temperature test ports for verifying accuracy of flow performance shall be available for all valve sizes.
- E. Butterfly Valves:
1. Manufacturers:
 - a. Bray Series 31 (NPS 2 through 20")
 - b. Belimo
 2. Description:
 - a. MSS SP-67, Type I, for bi-directional bubble-tight shut-off at full pressure rating of valve (minimum 150 psi) and be designed for bi-directional bubble-tight shut-off dead end service; disc and lining suitable for potable water; and minimum 2-inch

extension neck. Each valve shall be factory tested and field tested to prove valves have zero leakage with actuator mounted on valve.

- b. Single-Flange, Ferrous-Alloy Butterfly Valves: ANSI Class 125 cast iron body, full-lug type; blowout proof, 416 stainless steel stem; peroxide cured EPDM seat; aluminum bronze or Nylon 11 coated ductile iron disc, and Buna N ring stem and dirt seals.
3. Sizing: 1-psig maximum pressure loss at design flow rate.

2.9 DAMPERS

- A. General: Damper construction specifications are minimum required. Damper static pressure ratings shall meet or exceed the rating of the ductwork or system in which they are installed.
 1. Unless otherwise specified, dampers for modulating service shall be opposed blade design and dampers for two position service shall be parallel blade design.
 2. Coordinate dampers specified with equipment in other Division 23 Sections, including the following:
 - a. Section 23 7413 "Modular Air-Handling Units."
 - b. Section 23 7412 " Custom Air-Handling Units."
 - c. Section 23 3300 "Air Duct Accessories."
 - d. Section 23 3423 "HVAC Power Ventilators."
 3. Smoke and combination smoke and fire dampers are specified in Section 23 3300 "Air Duct Accessories."
- B. Control Dampers: AMCA-rated, opposed-blade design; 0.11-inch minimum, galvanized-steel frames with holes for external duct mounting; damper blades shall not be less than 0.06-inch galvanized steel with maximum blade width of 6 inches.
 1. Blades shall be secured to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade. Maximum 48 inch blade length.
 2. Operating Temperature Range: From minus 10 to plus 150 deg F.
 3. Seals: Inflatable type blade edging, or replaceable rubber type, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4 inches wg when damper is being held by torque of 50 in. x lbf; when tested according to AMCA 500D.
 4. Damper assembly shall have no sections longer than 48 inches wide or 48 inches high. Where greater length or height is required the assembly shall be made from a combination of sections.
 5. Connection rods transmitting motion from damper motors to damper, shall be sized to withstand as load equal to at least twice the minimum damper operating force without deflection. Lengths shall be adjustable. Links shall be cadmium plated steel, brass or bronze.
 6. Manufacturers:
 - a. Rectangular: Ruskin CD-36, American Warming VC-20/21, or Johnson Controls D-1300.
 - b. Round: McGill Airflow Corporation Type 1 or Type 2 high pressure type.

2.10 MISCELLANEOUS DEVICES

- A. Provide necessary relays, accumulators, valves, positioners, switches, transformers, etc. to make a complete and operable system.

- B. Time Delay Relays: Delay-on-energize or delay-on-release as shown; select range for the application as specified and shown.
 - 1. DPDT timed contacts with minimum continuous rating of 10 amps resistive at 120 VAC.
 - 2. Coils rated for continuous duty at plus or minus 10 percent of nominal coil pilot voltage.
 - 3. Manufacturers: Potter Brumfield, Magnecraft, Agastat, or Paragon.

- C. Control Relays: Normally open (NO) or normally closed (NC) contacts and number of poles required to perform the indicated functions.
 - 1. Contacts rated for no less than 110 percent of switched load, or a minimum continuous rating of 10 amps at 120 VAC.
 - 2. Coils rated for continuous duty at 100 percent plus or minus 10 percent of the nominal coil pilot voltage.
 - 3. Relays mounted within panels may be plastic encapsulated socket mounted type, or modular design with multiple convertible contacts, as required.
 - 4. Relays located outside of panels shall be housed in enclosures rated for the intended location.
 - 5. Manufacturers: Johnson Controls or approved equal.

2.11 THERMOMETERS

- A. Provide direct-reading duct thermometers that are readable by a person standing on the floor in the following locations:
 - 1. At air handling units, where indicated on the ATC schematics.

- B. Thermometers are specified in Section 23 0519 "Meters and Gages for Mechanical Piping."

2.12 ELECTRICAL WIRING

- A. General Wiring Requirements:
 - 1. Wiring shall comply with the requirements of local and national electric codes and Division 26 specification requirements, and the requirements herein specified.
 - 2. Electric wiring and wiring connections required for the installation of the ATC, as herein specified, shall be provided by this specification unless specifically shown or called for in other specifications.
 - a. Control wiring shall include connections to control devices, interlock wiring, control relays, and minor power wiring to auxiliary components for major pieces of apparatus. Minor power wiring, 120 volts and below, shall include requirements for such equipment as damper motors, solenoid valves, and interconnecting wiring on apparatus that has not been factory installed. In general, control wiring that is not factory installed or provided under other Divisions shall be provided.
 - b. Power wiring, for the purpose of this specification, shall be defined as follows: Wiring from the power source, i.e., panelboard, or motor control center, etc., to the disconnect switch or disconnect switch and starter including wiring from these switches to the apparatus.
 - 3. Power for control devices, whether or not interlocked with motor operation, shall be obtained from a separate 120 VAC source at the ATC panel or where directed. The Contractor shall be permitted to wire one control relay or one solenoid valve with maximum power draw of 50 VA, to derive pilot power directly from the motor starter control circuit. Devices are to be located remote and external from motor starter. Device wiring is to terminate on terminal blocks provided in motor starter compartments. No splices are permitted. Provide power wiring from the source to field mounted control devices and panels.

4. Coordinate with the work of others. The plans are diagrammatic only and are to be utilized as reference. Interconnection and coordination requirements necessary for a totally operational control system are the requirement of this Section.
5. Operate electric and electronic mechanical controls at maximum 120 volts or less. Provide voltage transformers and isolated relays where indicated or required for control systems that operate at voltage other than 120V ac.
6. Transformers other than those used in bridge circuits shall have primaries wound for the available current and secondaries wound for the correct control circuit voltage. Size to have capacity capable to operate simultaneously components served plus 25 percent overload for one hour. Enclose transformer in vented steel cabinet with conduit connections and provide disconnect switch on the primary side and fused cut-out on the secondary side.
7. Provide contactors, relays, and authority devices for control of single-phase equipment.
8. Duct smoke detectors are specified in Section 28 3100 "Fire Detection and Alarm Systems." Provide contactors for connection to both the DDC system and fan starter circuits.

B. Control Transmission Cabling:

1. Twisted, shielded-pair cable, rated for use in return air plenums.

2.13 TOUCHSCREEN INFORMATION KIOSK

A. Touchscreen Information Kiosk shall be "Energy Efficiency Education Dashboard (EEED)" by QA Graphics of Ankeny, Iowa, or approved equal. The Kiosk shall include but not be limited to the following:

1. The display shall be user interactive by touchscreen and displayed on screen and intranet.
2. User interface shall have 2D images and animations.
3. Information displayed shall include:
 - a. Current weather.
 - b. Daily historical building data from date of installation of electricity, water, heating water, and chilled water usage.
 - c. Campus map.
 - d. Live data including electricity, water, heating water, and chilled water usage.
 - e. Real-time information including outside air temperature and building energy consumption.
 - f. LEED rating system, including checklist and green features list.
4. Kiosk shall tie into the campus Building Automation System via BACnet interface.
5. Include "Building Leaderboard" feature for future use to monitor and display electric and water usage competition between 4 campus buildings.
 - a. Historical information to be displayed on Leaderboard to include daily, weekly, monthly, and yearly comparison of electricity and water.
 - b. Historical information to be represented by carbon footprint.

B. Dashboard Hardware:

1. 42 inch LCD touchscreen with Peerless SF650 mounting brackets.
2. 120 VAC, 15 VDC power supply.
3. Ethernet connection and USB ports.

- C. Gateway: BACnet connection to BAS, PC; connected to same network as the Dashboard and Data Manager.
- D. Data Manager: Web server with PHP 5.0.
- E. BAS Requirements:
 - 1. Provide live data points and graphics for:
 - a. Chilled water consumption (ton-hours).
 - b. Heating water consumption (MBH-hours).
 - c. Building electricity consumption (kWh).
 - d. Building water consumption (gallons).
 - 2. Provide BAS Ethernet connection for Gateway.
- F. Include manufacturer's standard warranty. Installation shall include in-person training of UM staff on maintenance and operation of Kiosk.

2.14 SOURCE QUALITY CONTROL

- A. Perform manufacturer's standard shop tests for each component.

PART 3 - EXECUTION

3.1 ACTUATOR APPLICATION SCHEDULE

- A. Generally, provide electric/electronic actuators.

3.2 VALVE APPLICATION SCHEDULE

- A. Generally, provide ball valves or pressure independent control valves for hydronic services.

3.3 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.
- B. Verify that duct-, pipe-, and equipment-mounted devices and wiring and pneumatic piping are installed before proceeding with installation.
- C. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.4 INSTALLATION

- A. Install systems and materials in accordance with manufacturer's instructions and roughing-in drawings, and details on drawings.
- B. Mount controllers at convenient locations and heights.
- C. Install equipment level and plumb.
- D. Install software in control units and operator workstation. Implement all features of programs to specified requirements and as appropriate to sequence of operation.

- E. Connect and configure equipment and software to achieve sequence of operation specified.
 - F. Verify location of thermostats, humidistats, and other exposed control sensors with plans, room details, and Architect before installation. Generally, locate all 48 inches above the floor; align centerline with centerline of adjacent light switches.
 - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern, supported by mechanical clips.
 - 2. Thermostats and humidistats located on exterior walls shall be mounted on back-insulated blocks.
 - G. Install guards on room sensors in the following locations:
 - 1. Stair wells.
 - H. Install automatic dampers according to Section 23 3300 "Air Duct Accessories."
 - I. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
 - J. Install labels and nameplates to identify control components according to Section 23 0553 "Identification for Mechanical."
 - K. Install hydronic instrument wells, valves, flow switches, flow meters, and other accessories according to Section 23 2113 "Hydronic Piping."
 - L. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
 - M. Provide weathershield/enclosure to protect actuators and linkages from outside conditions of snow and ice build-up.
 - N. Provide NEMA 4 enclosures for electric or electronic devices mounted in outdoor locations.
 - O. Mounting of Panels: Control panels shall be installed so that they are stable and fully supported throughout the entire panel, minimum one inch from the wall. Panels mounted on air system housings or ducts are not acceptable. Ensure that panels are free from obstructions to allow for ease of operation and maintenance.
 - P. Load and debug software required for an operational DDC System, including data base, operational parameters, and system control and application programs.
 - Q. Install flow meters in accordance with manufacturers written recommendations for straight piping lengths upstream and downstream of meter.
 - R. Install pneumatic piping in mechanical equipment rooms from source to valves, with maximum unsupported length of 36 inches. Purge tubing with dry, oil-free compressed air before connecting control instruments. Install pressure gages on branch lines to each valve.
- 3.5 ELECTRICAL WIRING AND CONNECTION INSTALLATION
- A. Install raceways, boxes, and cabinets according to Section 26 0533 "Raceways and Boxes for Electrical Systems."
 - 1. Minimum conduit size: 3/4 inch.

- B. Install building wire and cable according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Install control transmission cable according to industry standards and as follows:
 - 1. Mechanical rooms, areas where other conduit and piping are exposed, and in masonry walls: install cable in raceway.
 - 2. Outdoors: Install cable in Schedule 40 PVC conduit. Upon entering and leaving a building, each conductor, including ground shield, shall terminate on a surge protector designed to interrupt the circuit and shunt transient voltage to ground.
 - 3. Within drywall walls and above ceilings:
 - a. Cable may be run without conduit protection. Support control transmission cable from structure with tie wraps. It shall be the responsibility of the Contractor to ensure the integrity and proper shielding and grounding of control cable.
 - b. Cable may be run in telecommunications cable tray.
 - 4. Install below grade and outdoor cable in Schedule 40 PVC conduit. Upon entering and leaving a building, each conductor, including ground shield, shall terminate on a surge protector designed to interrupt the circuit and shunt transient voltage to ground.
 - 5. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 6. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 7. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 8. No splices or kinks shall be permitted in control transmission cable. Terminations shall be on panel-mounted terminal strips.
 - 9. Grounding shall be in accordance with ANSI C2. Ground wire shall be copper. Control cable, including communication links and sensor wiring, shall be grounded at only one point for the entire system. Sensor wiring ground wires shall be terminated at the DCP and connected to the communication link ground wire. Communication link ground wires shall be terminated and grounded at the CPU.
 - 10. Power wiring shall not be routed through the same raceway as control transmission cable.
 - 11. At Contractor's option, cable may be run in telecommunications cable tray.
- D. Low voltage (50 volt or less) remote control and signal wiring may be run in multi-conductors cable with PVC insulation, mylar binder and PVC jacket. Use "plenum approved" cable in return air plenums. Entire installation shall be in accordance with Article 725 NEC, and shall meet additional requirements noted. Cables carrying AC circuits sensitive to external field shall be shielded. Exception: Control wiring shall be in conduit in mechanical and electrical equipment rooms, in shafts and where exposed.
- E. Connect hand-off-auto selector switches to maintain automatic interlock controls when switch is in hand position.
- F. Control power may be derived from line side of a starter provided circuits are fused and controls so energized are associated only with this starter and motor.
- G. Control transformer furnished as an integral part of a starter shall not be used as a power source for additional control.
- H. Starter disconnect or separate switch immediately adjacent to starter shall disconnect power from line voltage or 120 volt control wiring entering starter.

- I. Controllers and Operators: Controls shall be designed to function properly with a power source voltage variation of plus or minus 10 percent.

3.6 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 1. Install piping adjacent to machine to allow service and maintenance.
- B. Pressure sensors installed on liquid lines shall have siphons. Pressure sensors shall have valves for isolation and venting, and taps for calibration. Pressure sensors shall be verified by calibration. Differential-pressure sensors shall have three-way manifold valves.
- C. Pressure switches installed on liquid lines shall have siphons. Pressure switches shall have valves for isolation and venting, and taps for calibration. Pressure switches shall be adjusted to the proper setpoint, and shall be verified by calibration. Pressure switches shall be mounted higher than the process connection. Differential-pressure switches shall have three-way manifold valves. Switch contact ratings and duty shall be selected for the expected load.
- D. Provide necessary pressure fittings for installation of work. Size (for the specific range) and adjust each differential-pressure switch used for fan and pump status to ensure reliable monitoring and eliminate false status feedback.
- E. Ground equipment.
- F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in

3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 1. Operational Test: Prior to testing, confirm system graphics are complete, points have been mapped into the graphics, and the graphics have been reviewed for content and completeness by the owner, architect, and construction manager. After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
 3. Calibration test electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 4. Instruments and sensors shall be field calibrated by comparison to known device, which is traceable to National Institute of Standards and Testing and has a certification that is less than a year old. Proof of certification shall be available on site for review upon request. The standards and accuracy requirements for calibration equipment shall be equal to or higher than the accuracy specified for the device being checked. Contractor shall document the field calibration and submit the documentation.
 5. Coordinate calibration with space temperature measurements specified in Section 23 0593 "Testing, Adjusting, and Balancing for HVAC."
- B. Engage a factory-authorized service representative to perform startup service.

1. Flow Meters – Engage the flow meter manufacturer to confirm meter installation is satisfactory and to make any adjustments to the meter operating parameters to offset the existing field conditions and to coordinate with the building automation vendor for performing meter startup, programming and integration with the building automation system.
- C. ATC contractor shall include 8 hours and a meeting with the University to prioritize alarm points and establish actions such as whom to email or call, type of alarm, etc.
- D. Replace damaged or malfunctioning controls and equipment.
 1. Start, test, and adjust control systems.
 2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
 3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.
- E. Place Building Automation System (BAS) in the required modes of operation as requested by the Testing and Balancing Contractor (TAB). Provide programming changes and reporting of data from the BAS needed to achieve proper performance.
- F. Re-check fan static pressure control setpoints to ensure that the static pressure setpoints are the lowest value which enables terminal units to deliver design maximum flow plus or minus 10 percent with the variable frequency controller at maximum speed. The TAB Contractor shall make any fan adjustments needed. Adjust setpoint as requested by the TAB Contractor.
- G. Re-check pump differential pressure control setpoints to ensure that the differential pressure setpoints are the lowest value which enables coil ATC valves to deliver design maximum flows plus or minus 10 percent. Adjust setpoint as requested by the TAB Contractor.
- H. Verify DDC as follows:
 1. Verify software including automatic restart, control sequences, scheduling, reset controls, and occupied/unoccupied cycles.
 2. Verify operation of operator workstation.
 3. Verify local control units including self-diagnostics.
- I. Initial Demonstration Test: Upon the completion of work and functional performance acceptance period, tests, and specific function demonstrations, and at a time agreed upon, operate the systems, in parts, for sufficient length of time but not less than 30 days to determine whether the systems as a whole are functioning properly.
 1. Provide log identifying failures that occur. Indicate point name and number, time and date of failure, and time and date of return to service.
- J. Most of the mechanical systems are included in the Commissioning Program. Pretest the functional operation of the system and document tests with the construction manager, such that the first time through the system operation is not during the commissioning agent's Functional Test. Refer to the following specification sections for requirements associated with Commissioning:
 1. Section 01 9113 "General Commissioning Requirements".

3.8 DEMONSTRATION

- A. Refer to Section 01 7350 "Demonstration and Training" for training requirements for Owner's maintenance personnel and building occupants.

3.9 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

END OF SECTION

SECTION 23 0901

AIR MEASURING 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. This Section includes the following air measuring systems for mechanical systems:
 - 1. Air-flow measuring systems in ductwork.
 - 2. Air-flow measuring systems in plenums.
 - 3. Static-pressure measuring systems in ductwork.
- B. Related Sections include the following:
 - 1. Section 23 3300 "Air Duct Accessories" for general installation requirements.
 - 2. Section 23 0900 "Instrumentation and Control for HVAC" for wiring.
 - 3. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - a. Section 01 9113 "General Commissioning Requirements."

1.3 DEFINITIONS

- A. Combined Tested Accuracy: The combined percentage accuracy of the air-flow or static-pressure measuring system (sensor and transmitter) when installed in accordance with manufacturer's written recommendations.
- B. DDC: Direct digital controls.
- C. Installed Accuracy: The combined percentage accuracy of the air-flow or static-pressure measuring system (sensor and transmitter) in the location indicated on the drawings.
- D. Measuring System: Combination of sensor(s), transmitter(s), and monitor(s).
- E. Tested Accuracy: The percentage accuracy of sensor or transmitter when installed in accordance with manufacturer's written recommendations.

1.4 SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each air measuring system. Indicate dimensions, capacities, performance characteristics, electrical characteristics, materials of construction, installation details, mounting type, air pressure drop, and installation and startup instructions for each type of product indicated.
 - 1. Each air measuring device labeled with setting or adjustable range of control, minimum placement requirements, sensor density, sensor distribution, and installed accuracy.

- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Installation Drawings: Prepared by manufacturer for each system indicating location and mounting of each component, dimensions relative to plenum walls, baffles, etc.
 - 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 - 3. Details of panel faces, including controls, instruments, and labeling.
 - 4. Schedule of air-flow measuring devices indicating airflow, pressure drop, and compliance with specified installed accuracy at minimum and maximum air-flow rates for each location.
- C. Maintenance Data: For systems to include in maintenance manuals specified in Division 01. Include the following:
 - 1. Maintenance instructions and lists of spare parts for each type of air measuring device.
 - 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 - 3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - 4. Calibration records and list of set points.
- D. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- E. Project Record Documents: Record actual locations of air measuring device components.
- F. Source quality control test reports.

1.5 QUALITY ASSURANCE

- A. Source Limitations:
 - 1. Air-Flow Measuring Devices: Obtain air-flow measuring devices through one source from a single manufacturer with resources to provide products complying with requirements indicated without delaying the Work.
 - 2. Static-Pressure Measuring Devices: Obtain static-pressure measuring devices through one source from a single manufacturer with resources to provide products complying with requirements indicated without delaying the Work.
- B. Installer Qualifications: An experienced installer who is an authorized representative of the air measuring system manufacturer for both installation and maintenance of units required for this Project.
- C. Manufacturer Qualifications: A firm experienced in manufacturing air measuring systems similar to those indicated for this Project and with a record of successful in-service performance for a minimum of 10 years.
- D. 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.
- E. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
- B. Storage: Store materials in a clean and dry area indoors, protected from weather and damage, and in accordance with manufacturer's instructions.
- C. Handling: Handle and lift air measuring devices in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.
- D. Factory-Mounted Components: Where devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.7 COORDINATION

- A. Coordinate location of air measuring system devices with plans, ductwork, and equipment before installation.
- B. Coordinate supply of conditioned electrical circuits for air measuring devices.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 INSTALLED ACCURACY

- A. Provide devices with specified installed accuracies throughout the measurement range (minimum to maximum) and with inlet and outlet conditions indicated on the drawings.
- B. Air-Flow Measuring Systems Installed Accuracy: Maximum plus or minus 5 percent.
- C. Static-Pressure Measuring Systems Installed Accuracy: Maximum plus or minus 5 percent.

2.3 THERMAL DISPERSION AIR-FLOW MEASURING DEVICES

- A. Manufacturers: Ebtron, Inc. Gold Series.
- B. Sensor Construction:
 - 1. Duct and plenum mounted sensors: Anodized aluminum alloy tube with stainless steel mounting brackets.
- C. Each measuring system shall consist of one or more multi-point measuring probes and a single microprocessor-based transmitter.

- D. Transmitters shall have an LCD display capable of displaying average air-flow and temperature and air-flow and temperature of each sensor. Air-flow shall be field configurable to be displayed as a velocity or volumetric rate. Each transmitter shall operate on 24 VAC.
- E. Each sensing point shall independently determine the air-flow rate and temperature, which shall be equally weighted and averaged by the transmitter prior to output.
- F. A single manufacturer shall provide both the air-flow/temperature measuring probe(s) and transmitter at a given measurement location. Probes and transmitters shall not require field matching for proper operation.
- G. Operating Air-flow Range: 50-5,000 FPM unless otherwise indicated on the plans.
- H. Operating Temperature and Humidity Range for Measuring Probes: -20 deg. F to 140 deg. F and 0-99% RH (non-condensing).
- I. Operating Temperature Range for the Transmitter: -20 deg. F to 120 deg. F. The transmitter shall be protected from weather and water; provide NEMA 3R enclosure with heater and cooling fans for transmitters mounted outside or within air handlers.
- J. Air-flow Sensor Accuracy: Plus or minus 2 percent of reading over the entire operating air-flow range. Wind tunnel calibrate or verify against standards that are traceable to NIST.
1. Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the combined total accuracy meets the performance requirements of this specification throughout the measurement range.
- K. Temperature Sensor Accuracy: Plus or minus 0.15 deg. F over the entire operating temperature range. Calibrate or verify against standards that are traceable to NIST.
- L. Minimum Sensor Quantity for Each Location:
1. Ducts and plenums:
- | <u>Area (sq.ft.)</u> | <u>Sensors</u> |
|----------------------|----------------|
| <=1 | 2 |
| >1 to <4 | 4 |
| 4 to <8 | 6 |
| 8 to <12 | 8 |
| 12 to <16 | 12 |
| >=16 | 16 |
- M. The transmitter shall be capable of communicating with the building DDC system using the following interface options:
1. Linear analog output signal: Field selectable, fuse protected and isolated, 0-10VDC and 4-20mA (4-wire).
2. RS-485: Field selectable ModBus-RTU and Johnson Controls N2 Bus.
3. 10 Base-T Ethernet: Field selectable ModBus TCP and TCP/IP.
4. LonWorks Free Topology.
- N. Minimum Outputs: Airflow and temperature.
- O. Airflow measuring system shall be UL listed as an entire assembly.

- P. The manufacturer's authorized representative shall review and approve placement of each sensor and transmitter and operating air-flow rates for each measurement location indicated on the plans. A written report shall be submitted to the Architect if any measurement locations do not meet the manufacturer's placement requirements.

2.4 PITOT TUBE STATIC PRESSURE MEASURING SYSTEM

A. Probes:

1. Manufacturer: Air Monitor Corporation.
2. Style: Duct static traverse probes capable of continuously monitoring the duct or system static pressure it serves.
3. Construction: Each duct static traverse probe shall contain multiple static pressure sensors located along the exterior surface of the cylindrical probe. Sensors shall not protrude beyond the surface of the probe. The duct static traverse probes shall be of extruded aluminum construction and be complete with threaded end support rod, sealing washer and nut, and mounting plate with gasket and static pressure signal fitting.
4. Performance: The static traverse probes shall be capable of producing a steady, non-pulsating signal of standard static pressure, without need for correction factors, with an instrument accuracy of 2 percent.

B. Transmitter:

1. Manufacturer: Veris PX Series.
2. Style: Electronic transmitter with LCD display, 3-way manual zeroing valve, user selectable square root function; designed for exposed mounting in protected (building) areas to measure static pressure or differential pressure, and output a 4-20 mA output linear to static pressure, airflow velocity, or volume.
3. Performance: The transmitter shall conform to the following:
 - a. Accuracy: Plus or minus 0.5 percent of Natural Span, including non-linearity, hysteresis, and non-repeatability.
 - b. Spans: (7) Natural, from 0-0.10 inches wg to 0-10.0 inches wg.; (7) Bi-Polar.
 - c. Temperature Effect: Zero: Plus or minus 0.025 percent of Full Scale/deg F.
 - d. Span: Plus or minus 0.025 percent of Full Scale/deg. F.
 - e. Power Supply: 14-40 VDC for all models, reverse polarity short-circuit proof.
 - f. Analog Outputs: 4-20 mADC, 2-wire configuration.
 - g. Temperature Limits: 40 to 120 deg. F Operating.
 - h. Maximum Overpressurization: 25 psig.
4. Locate in BAS panel, with sensing tubes routed to probes.

2.5 FACTORY MOUNTING

- A. Air-flow measuring devices located within factory-fabricated penthouse air-handling units shall be shipped to the air-handling unit manufacturer and installed in the factory.

2.6 SOURCE QUALITY CONTROL

- A. Factory Tests: Factory test and calibrate sensor, transducer, and monitor for proper operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect areas to receive air-flow and static-pressure measuring devices. Notify the Architect of conditions that would adversely affect the installation or subsequent utilization of the air-flow or static-pressure measuring devices. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 AIR-FLOW MEASURING DEVICE APPLICATIONS

- A. Install duct- or plenum- mounted air-flow measuring devices not within air handling units utilizing thermal dispersion probes.
- B. Install duct- and plenum-mounted air-flow measuring devices within air handling units utilizing thermal dispersion probes.

3.3 STATIC-PRESSURE MEASURING DEVICE APPLICATIONS

- A. Install pitot tube probe static-pressure measuring devices in ductwork.

3.4 INSTALLATIONS

- A. Assemble and install connections, tubing, and accessories between sensors, transmitters, and monitors as prescribed by manufacturer's written instructions.
- B. Install air measuring systems in accessible positions in duct and air-handling systems.
- C. Install air measuring sensors at locations indicated on the drawings, and with at least minimum straight lengths of duct upstream and downstream from element as prescribed by manufacturer's written instructions.
- D. Install transmitter and monitor electronics at locations indicated on the drawings and in accordance with manufacturer's installation instructions.
- E. Penetrations through the air handler walls, ductwork, or hood shall provide some means to prevent tubing and wiring chafe, and be sealed air- and water-tight.
- F. Pitot Tube Devices:
 - 1. Install probes such that pressure connections are at or above the centerline of the probe. Connection tubing attaching to the probes shall be pitched downward so that any accumulated moisture can drain back towards the probe. Tubing shall be installed so that there are no pockets where moisture might accumulate.
 - 2. Install the transmitter such that it is located at a slightly higher elevation than the highest probe. Transmitter shall be mounted so that the pressure connections are on the bottom of the enclosure. Connecting tubing shall be pitched downward and away from the transmitter so that any accumulated moisture can drain back towards the probe. Tubing shall be installed so that there are no pockets where moisture might accumulate.

3.5 CONNECTIONS

- A. Install air measuring devices to allow service and maintenance for air measuring devices, machines, and equipment.
- B. Connect thermal dispersion, pitot tube, and pressure differential system elements to transmitters and monitors.
- C. Provide electric wiring and connections required for air measuring systems. Provide wiring according to Section 23 0900 "Instrumentation and Control for HVAC."
- D. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 CLEANING

- A. After Substantial Completion, clean air measuring systems.

3.7 ADJUSTING

- A. Setup and calibrate air-measuring devices according to manufacturer's written instructions, after installation.

3.8 COMMISSIONING

- A. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - 1. Section 01 9113 "General Commissioning Requirements".

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-measuring devices. Refer to Section 01 7350 "Demonstration and Training."

3.10 WARRANTY SERVICE

- A. After Substantial Completion, perform a calibration check (compare transmitter output to traverse) for pitot tube and differential pressure probe transmitters at 6 months, 12 months, 18 months, and 23 months after substantial completion. Refer to Section 23 0593 "Testing, Adjusting, and Balancing for HVAC". If transmitter is out of calibration, engage a factory-authorized service representative to calibrate transmitter.
- B. After Substantial Completion, engage a factory-authorized service representative to calibrate pitot tube static pressure measuring transmitters at 23 months after substantial completion.
- C. Clean air measuring system sensing devices and air straighteners within the airstream at the following intervals throughout the warranty period:
 - 1. Supply Air Service: 18 and 23 months.

2. Return and Outdoor Air Service: 3, 6, 9, 12, 15, 18, 21, and 23 months.

END OF SECTION

SECTION 23 2113

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. This Section includes piping, special-duty valves, and hydronic specialties for hot-water heating, chilled-water cooling, condenser water systems; glycol cooling water system; makeup water for these systems; blowdown drain lines; and condensate drain piping.
- B. Related Sections include the following:
 - 1. Section 23 0519 "Meters and Gages for Mechanical Piping" for thermometers, pressure gages, and thermowells.
 - 2. Section 23 0553 "Identification for Mechanical" for labeling and identifying hydronic piping.
 - 3. Section 23 0900 "Instrumentation and Control for HVAC" for temperature-control valves and sensors.
 - 4. Section 23 2123 "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
 - 5. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - a. Section 01 9113 "General Commissioning Requirements."
 - b. Section 23 0800 "Commissioning of Mechanical Systems."

1.3 DEFINITIONS

- A. PVC: Polyvinyl chloride.

1.4 SUBMITTALS

- A. Product Data:
 - 1. For each type of pipe, fitting, and joint indicated.
 - 2. For each type of hydronic specialty.
 - 3. For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for calibrated balancing valves.
- B. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
- C. Welding Certificates: Copies of certificates for welding procedures and personnel.

- D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
- E. Pipe Cleaning/Flushing Reports.
- F. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Section 01 7823 "Operation and Maintenance Data."

1.5 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.6 COORDINATION

- A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including building structure, electrical conduit and raceway systems, light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe sleeve installations for foundation wall penetrations.
- C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.
- D. Coordinate pipe fitting pressure classes with products specified in related Sections.
- E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03 Sections.
- F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Section 07 8413 "Penetration Firestopping" for fire and smoke wall and floor assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Balancing Valves:
 - a. Tour & Andersson / Victaulic.

2. Eccentric Plug Valves:
 - a. General Signal; DeZurik Unit.
 - b. Milliken Valve Company
3. Pressure-Reducing Valves:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Conbraco Industries, Inc.
 - d. ITT Bell & Gossett; ITT Fluid Technology Corp.
 - e. Spence Engineering Company, Inc.
 - f. Watts Industries, Inc.; Watts Regulators.
4. Safety Valves:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Conbraco Industries, Inc.
 - d. ITT McDonnell & Miller Div.; ITT Fluid Technology Corp.
 - e. Kunkle Valve Division.
 - f. Spence Engineering Company, Inc.
5. Expansion Tanks:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. ITT Bell & Gossett; ITT Fluid Technology Corp.
 - d. Patterson.
6. Air Separators and Air Purgers:
 - a. Armstrong Pumps, Inc.
 - b. ITT Bell & Gossett; ITT Fluid Technology Corp.
 - c. Spirotherm.
7. Flowmeter Fittings:
 - a. Badger Meter, Preso Differential Pressure Meters
 - b. Bailey-Fischer & Porter Co.
 - c. Barco.
 - d. Flow Design, Inc.
 - e. Gerand Engineering Co.
 - f. Hyspan Precision Products, Inc.
8. Strainers:
 - a. Mueller Steam Specialty.
 - b. Approved equal.

2.2 PIPING MATERIALS

- A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. DWV Copper Tubing: ASTM B 306, Type DWV.
- C. Wrought-Copper Fittings: ASME B16.22.
- D. Wrought-Copper Unions: ASME B16.22 with red bronze ring nut.

- E. Copper or Cast Bronze Flanges: ASME B 16.24, including bolts, nuts, and gaskets of the following:
 - 1. Facings: Raised face.
 - 2. Class: Equal to adjacent flange of valve or appurtenance.
- F. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- G. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

2.4 STEEL PIPE AND FITTINGS

- A. Steel Pipe, NPS 2 and Smaller: ASTM A 53, Type S (seamless), Grade B, Schedule 40, black steel, plain ends. Type F (continuous weld) piping is not acceptable.
- B. Steel Pipe, NPS 2-1/2 through NPS 12: ASTM A 53, Type E (electric-resistance welded), Grade B, Schedule 40, black steel, plain ends. Type F (continuous weld) piping is not acceptable.
- C. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.
- D. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- E. Malleable-Iron Unions: ASME B16.39; Class 250, brass seat.
- F. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.
- G. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- H. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- I. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
- J. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.5 PLASTIC PIPE AND FITTINGS

- A. PVC Pressure Plastic Pipe: ASTM D 1785, Schedules 40 and 80, plain ends.
- B. Solid-Wall Schedule 40 PVC Pipe: ASTM D 2665, drain, waste, and vent.
- C. PVC Pressure Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

- 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. PVC Solvent Cement: ASTM D 2564.

2.6 VALVES

- A. Globe, check, ball, and butterfly valves are specified in Section 23 0523 "General Duty Valves for Mechanical Piping."
- B. General valve requirements for valves (actuators, extension necks, etc.) specified in this section are specified in Section 23 0523 "General Duty Valves for Mechanical Piping".
- C. Refer to Part 3 "Valve Applications" Article for applications of each valve.
- D. Balancing Valves, Sizing: Line size, except where valve is outside of manufacturer's written recommended flow range.
 - 1. Maximum Permanent Pressure Drop: 2 feet of head.
 - 2. Minimum Achievable Flow Rate: 2.0 GPM at maximum 2.5 feet of head permanent pressure drop.
- E. Balancing Valves, NPS 2 and Smaller: The balancing valves shall be Y-pattern globe style design and all metal parts of nonferrous, pressure die cast, nonporous Ametal, 125-psig working pressure, 250 deg F maximum operating temperature, and having threaded ends. Valves shall have four (4) 360° adjustment turns of the handwheel for precise setting with hidden memory to provide a tamper-proof balancing setting. Handwheel shall have digital readout. The handwheel can be installed in any position without affecting performance.
- F. Balancing Valves, NPS 2-1/2 and Larger: The balancing valves shall be Y-pattern globe style design with ductile iron body and all other wetted parts of nonferrous, pressure die cast, nonporous Ametal, 125-psig working pressure, 250 deg F maximum operating temperature, and having threaded ends. Valves shall have minimum of eight (8) 360° adjustment turns of the handwheel for precise setting with hidden memory to provide a tamper-proof balancing setting. Handwheel shall have digital readout. The handwheel can be installed in any position without affecting performance.
- G. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, 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 capability for field adjustment.
- H. Safety Valves: Diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall be field adjustable to pressures indicated on the drawings.
- I. Drain valves are specified in Section 22 4100 "Plumbing Specialties."

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; with NPS 1/8 discharge connection and NPS 1/4 inlet connection.
 - 1. Vents at top of vent chambers or coils shall be 1/4 inch ball valves.
- B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with piped discharge connection and NPS 3/4 inlet connection. Include ball valve upstream of vent connection, complying with Section 23 0523 "General Duty Valves for Mechanical Piping".
- C. Expansion Tanks: Welded carbon steel, rated for 125-psig working pressure and 240 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity by a full acceptance flexible replaceable bladder securely sealed into tank. Tank to have label indicating bladder pressure rating. Provide pressure gage on air side of tank with isolation valves and charging valve. Include drain fitting and taps for pressure gage and air-charging fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Factory-fabricate and test tank with taps and supports installed and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
- D. Air Separators: Welded black steel; ASME constructed and labeled for 125-psig minimum working pressure and 350 deg F maximum operating temperature; threaded inlet and outlet connections for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger; threaded blowdown bottom connection; threaded expansion tank/make-up water top connections threaded air vent top connection; high capacity cast-iron body, automatic air vent with ball valve on inlet, 3/4-inch inlet, 3/8 inch outlet. Provide units in sizes for full-system flow capacity.
- E. Y-Pattern Strainers: 125-psig working pressure; cast-iron body (ASTM A 126, Class B), flanged ends for NPS 2-1/2 and larger, bronze body, threaded connections for NPS 2 and smaller, bolted cover, perforated stainless-steel basket, and bottom drain connection. Perforations shall not exceed 1/32 inch; at terminal equipment control valves, provide 0.009 fine mesh screens.
- F. Suction Diffusers: Refer to Section 23 2123 "Hydronic Pumps."

2.8 FLOWMETER FITTINGS

- A. Description: Differential-pressure design for installation in piping; with calibrated flow-measuring element, separate flowmeter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flowmeter, and system fluid.
- B. Construction:
 - 1. Venturi Body: Bronze, brass, or factory-primed steel, suitable for the piping system; with brass fittings and attached tag with flow conversion data.
 - a. Basis-of-design: Preso CV Series
 - b. End Connections for NPS 2 and Smaller: Threaded or solder.
 - c. End Connections for NPS 2-1/2 and Larger: Flanged or welded.
 - d. Pressure and Temperature Plugs with Extensions.
 - e. NPS 0.25 Ball Valves with Extensions
 - 2. Insertion Pitot Tube: 316 stainless steel probe, "y" type brass head, thread-o-let pipe mounting connection suitable for the piping system; with brass fittings and attached tag for flow conversion data.

- a. Basis-of-design: Preso BAR Ellipse
 - b. Extension neck for insulated piping systems
- C. Pressure Rating: 150 psig.
- D. Temperature Rating: 250 deg F.
- E. Range: Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.
- F. Maximum Permanent Pressure Drop: Two feet of head at design flow rate.
- G. Accuracy: Plus or minus 2 percent for water temperatures from 50 to 215 deg. F.
- H. Portable Indicators: Differential-pressure type calibrated for connected flowmeter element and having two 12-foot hoses in carrying case. Provide two indicators, with scales for flow ranges within the building.
- 1. Scale: Gallons per minute.
 - 2. Accuracy: Plus or minus 2 percent between 20 and 80 percent of range.
- I. Operating Instructions: Include complete instructions with each flowmeter.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Heating and Chilled Water, NPS 2-1/2 and Smaller: Aboveground, use Type L drawn-temper copper tubing with soldered joints.
- B. Piping for Side-Stream Filter Housing and Shot Feeders: Type L drawn-temper copper tubing with soldered joints.
- C. Condensate Drain and Equipment Drainage Lines: Type L drawn-temper or DWV copper tubing with soldered joints.
 - 1. For underground conditions, provide Schedule 40 PVC drain, waste, and vent pipe and fittings, solvent cement unions.

3.2 VALVE APPLICATIONS

- A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
 - 1. Shutoff Duty: Ball, and butterfly valves.
 - 2. Throttling Duty: Globe, ball, and butterfly valves.
 - 3. Balancing Duty: Globe balancing valves.
- B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install balancing valves and flow meter fittings at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
- C. Install balancing valves and flow meter fittings in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.

- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

3.3 PIPING INSTALLATIONS

- A. Refer to Section 23 0500 "Common Work Results for Mechanical" for basic piping installation requirements.
- B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- C. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- D. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- E. Install equipment drain and condensate drain piping at a uniform grade of 0.5 percent downward in direction of flow.
- F. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- G. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- H. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated.
 - 1. Install two nipples; ball valve and threaded cap in blowdown connection of strainers. Install NPS 3/4 ball valve for strainers NPS 2 and larger; match size of strainer blowoff connection for strainers smaller than NPS 2.
 - 2. Orient strainers in horizontal pipe, with the strainer basket facing down.
- I. Anchor piping for proper direction of expansion and contraction.
- J. Use long sweep elbows throughout.
- K. Install underground PVC piping according to ASTM D 2321.3.

3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Section 23 0529 "Hangers and Supports for Mechanical Piping and Equipment." Comply with requirements below for maximum spacing of supports.
- B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 4. Spring hangers to support vertical runs.
 5. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
 8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
 9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.
- 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.

3.5 PIPE JOINT CONSTRUCTION

- A. Refer to Section 23 0500 "Common Work Results for Mechanical" for joint construction requirements for soldered and brazed joints in copper tubing; and threaded, welded, and flanged joints in steel piping; and solvent-welded joints for PVC piping.

3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents in mechanical equipment rooms only at high points of system piping, at heat-transfer coils, and elsewhere as required for system air venting. Install shut-off valve at each vent. Extend discharge piping (minimum 1/4 inch annealed copper) to nearest floor drain, service sink, or drain pipe.
- C. Install piping to expansion tank with a 2 percent upward slope toward tank.

- D. Install air separator in pump suction lines. Install piping to compression tank with a 2 percent upward slope toward tank. Install blowdown piping with ball valve; extend to nearest drain.
- E. Install expansion tanks on housekeeping pads. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements.

3.7 FLOWMETER FITTINGS

- A. General: Venturi type flow meter fittings, except at pump connections.
 - 1. At Pump Connections: Pitot tube type.
- B. Install flowmeter fittings in accessible positions in piping systems and with at least minimum straight lengths of pipe upstream and downstream from fittings, in accordance with manufacturers written instructions.

3.8 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be same as for equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install ports for pressure and temperature gages at coil inlet connections.

3.9 FIELD QUALITY CONTROL

- A. Coordinate with the independent testing agency and UM HVAC System operational personnel to allow for visual inspection and testing.
 - 1. Refer to Section 23 0500 "Common Work Results for Mechanical" for requirements for weld testing and inspection by an independent testing agency.
- B. Test, flush and clean hydronic piping per Section 23 0500 "Common Work Results for Mechanical"
- C. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination (as indicated below) during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush system with clean water. Clean strainers.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- D. Perform the following tests on hydronic piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that's safe for workers and compatible with piping may be used.
 - 2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
 - 3. Check expansion tanks to determine they are not air bound and system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
 5. After hydrostatic test pressure has been applied for at least 12 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare and submit a written report of the above testing to the Architect.
- E. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
1. Section 01 9113 "General Commissioning Requirements".
 2. Section 23 0800 "Commissioning of Mechanical Systems".

3.10 ADJUSTING

- A. Mark actuator position of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- B. Perform these adjustments before operating the system:
1. Open valves to fully open position. Close coil bypass valves.
 2. Check pump for proper direction of rotation.
 3. Set automatic fill valves for required system pressure.
 4. Check air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
 7. Lubricate motors and bearings.

3.11 CLEANING

- A. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. Flushing shall be witnessed by the Construction Manager. Minimum flushing velocity shall be 6 feet per second. Refer to Section 23 0500, "Common Work Results for Mechanical" for additional requirements. Prepare report and submit for record.
- B. Chemical cleaning is specified in Section 23 2500 "HVAC Water Treatment."

END OF SECTION

SECTION 23 2123

HYDRONIC PUMPS

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. This Section includes the following:
 - 1. Close-coupled, in-line centrifugal pumps.
 - 2. Separately coupled, base-mounted, end-suction centrifugal pumps.
 - 3. Close-coupled, in-line circulator pumps.
 - 4. Automatic condensate pump units.
- B. Related Sections include the following:
 - 1. Section 23 0513 "Common Motor Requirements for Mechanical Equipment" for related motor requirements.
 - 2. Division 22 Sections for Plumbing pumps.
 - 3. Most of the HVAC systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - a. Section 01 9113 "General Commissioning Requirements."
 - b. Section 23 0800 "Commissioning of Mechanical Systems."

1.3 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPDM: Ethylene Propylene Diene Monomer
- C. EPT: Ethylene propylene terpolymer.

1.4 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities, weights (shipping, installed, and operating), pump speed, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves (for parallel pumps, include single and parallel operation). Curves shall indicate capacity versus head, impeller diameters, efficiency, and brake horsepower, for full range (from shut-off head to free delivery). Include suction diffuser inlet and outlet size for each individual pump.
- B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

- C. Manufacturer Statement: Include statement of understanding that coupling furnished on pumps served by VFCs are fully compatible and suitable for VFC service.
- D. Pump Alignment Reports.
- E. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.
- B. 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.
- C. UL Compliance: Comply with UL 778 for motor-operated water pumps.
- D. Pump Standards: Hydronic Institute
 - 1. HI 1.1-1.5-00 Centrifugal Pumps for Nomenclature, Definitions, Application and Operation (ANSI).
 - 2. HI 2.1-2.5-00 Vertical Pumps for Nomenclature, Definitions, Application and Operation (ANSI).

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Mechanical Seals: One mechanical seal for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles below where titles introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 GENERAL PUMP REQUIREMENTS

- A. Pump Units: Factory assembled and tested.
- B. Motors: Comply with requirements in Section 23 0513 "Common Motor Requirements for Mechanical Equipment." Motors shall be non-overloading with respect to nameplate horsepower throughout the impeller performance curve.
- C. Pumps shall be selected so that the operating point on the selected impeller curve will be at or to the left of, and not more than 5 percent below the point of maximum efficiency. Impeller size for specified duty shall not exceed 85 percent of volute diameter.

2.3 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS (TYPE IL)

- A. Manufacturers:
1. Basis of Design: Bell & Gossett; Div. of ITT Industries.
 2. Armstrong Pumps Inc.
 3. Aurora Pump; Division of Pentair Pump Group.
 4. Patterson.
- B. Description: Centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:
1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange or union end connections.
 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
 3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
 5. Pump Bearings: Permanently lubricated; ball bearings.
- D. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing.

2.4 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS (TYPE ES)

- A. Manufacturers:
1. Basis of Design: Bell & Gossett; Div. of ITT Industries.
 2. Armstrong Pumps Inc.
 3. Aurora Pump; Division of Pentair Pump Group.
 4. Patterson.
- B. Description: Centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:
1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
 3. Pump Shaft: Carbon steel, with stainless steel shaft sleeve.
 4. Mechanical Seal: Internally flushed type, with carbon rotating ring against a silicon carbide seat held by a stainless-steel spring, and ethylene propylene bellows.
 5. Pump Bearings: Permanently-lubricated ball bearings.
- D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor, EPDM coupling sleeve specifically designed for variable-speed applications through variable frequency controllers. Shaft coupling shall electrically insulate against high frequency currents such that the pump-shaft and pump-bearings are isolated from inverter induced currents within the motor, motor-shaft, and motor-bearings.
- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor. Provide tapped hole to pipe away leakage and condensation. Provide stainless steel drain pan with FNPT connection for pumps manufactured without drainable base.
- G. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment.
1. Motors shall meet requirements for variable frequency controller applications listed in Section 23 0513, "Common Motor Requirements for Mechanical Equipment."

2.5 CLOSE-COUPLED, IN-LINE CIRCULATOR PUMPS (TYPE C)

- A. Manufacturers:
1. Basis of Design: Bell & Gossett; Div. of ITT Industries.
 2. Armstrong Pumps Inc.

3. Aurora Pump; Division of Pentair Pump Group.
 4. Patterson.
- B. Description: Centrifugal, horizontal, close-coupled, permanently lubricated in-line pump, with watertight seal. Rate pump for 150-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:
1. Casing: Bronze body, with stainless steel face plate, and threaded companion-flange or union end connections.
 2. Impeller: 30 percent glass-filled Noryl.
 3. Pump Shaft: Carbon steel, with stainless steel shaft sleeve.
 4. Mechanical Seal: Carbon.
 5. Pump Bearings: Permanently lubricated, sealed precision ball bearings.
- D. Motor: Single speed, with sealed precision ball bearings, unless otherwise indicated.

2.6 AUTOMATIC CONDENSATE PUMP UNITS

- A. Manufacturers:
1. Aurora Pump; Division of Pentair Pump Group.
 2. Beckett Corporation.
 3. Hartell Pumps Div.; Milton Roy Co.
 4. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
 5. MEPCO (Marshall Engineered Products Co.).
- B. Description: Factory-packaged units with corrosion-resistant pump, plastic tank with cover, 6-foot long 120-volt power cord, rubber mounting feet, thermal overload protection, external tank anti-sweat switch, external test/run lever, check valve, high level shutoff switch (wired to close CHW valve upon activation), and automatic controls.
- C. Minimum Capacity: 40 GPH at 15 feet w.g. head.

2.7 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup (0.007 fine mesh) and bronze or stainless-steel permanent (3/16" perforations) strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support foot.
1. Select suction diffuser to match pump inlet and pipe size.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

- A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Section 23 0500 "Common Work Results for Mechanical."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 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.
- B. Cast-in-place concrete materials and placement requirements are specified in Division 03.
- C. Refer to Section 23 0548 "Mechanical Vibration Control" for inertia bases and vibration isolators.

3.3 PUMP INSTALLATION

- A. Comply with HI 1.4 and HI 2.4.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
 - 1. Support pump suction diffusers on pump inertia base.
- D. Install close coupled in-line pumps with continuous-thread hanger rods and vibration isolation hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Section 23 0548 "Mechanical Vibration Control." Fabricate brackets or supports as required. Hanger and support materials are specified in Section 23 0529 "Hangers and Supports for Mechanical Piping and Equipment."
- E. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
 - 1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
 - 2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.
 - 3. Grout pump base.
 - 4. Refer to Section 2 30548 "Mechanical Vibration Control" for inertia bases and vibration isolators.
- F. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain or to sloped, gravity condensate drain main – refer to floor plans for termination point. Vibration isolation devices are specified in Section 23 0548 "Mechanical Vibration Control."
- G. Refer to installation details on drawings for additional requirements.

3.4 ALIGNMENT

- A. Engage a factory-authorized service representative to supervise pump alignment.
- B. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
- C. Comply with pump and coupling manufacturers' written instructions.
- D. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation and HI 2.1-2.5, "Vertical Pumps for Nomenclature, Definitions, Application and Operation."
- E. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.
- F. Prepare report and submit for record.

3.5 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install flexible connectors on suction and discharge sides of pumps between pump casing and valves.
- F. Install drainage piping from pump base mounting frame to floor drain.
- G. Install check valve and ball valve on each condensate pump unit discharge.
- H. Install electrical connections for power, controls, and devices.
- I. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
- K. Install flow sensor rings with readout ports on the discharge side of pumps (readout shall be water flow in GPM).

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

2. Check piping connections for tightness.
3. Remove start-up strainers after systems are flushed clean and replace with permanent strainers.
4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.7 COMMISSIONING

- A. Most of the HVAC systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 1. Section 01 9113 "General Commissioning Requirements".

3.8 DEMONSTRATION

- A. Refer to Section 01 7350 "Demonstration and Training" for training requirements for Owner's maintenance personnel and building occupants.

END OF SECTION

SECTION 23 2300
REFRIGERANT 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. This Section includes field installed, refrigerant piping used for connecting the split system heat pump units.
- B. Related Sections include the following:
 - 1. Division 07 for roof curbs, piping supports, and roof penetration boots.
 - 2. Section 07 8413 "Penetration Firestopping" systems for materials and methods for sealing pipe penetrations through fire and smoke barriers.
 - 3. Section 07 9200 "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.
 - 4. Section 23 0529 "Hangers and Supports for Mechanical Piping and Equipment" for pipe supports and installation requirements.
 - 5. Section 23 0553 "Identification for Mechanical" for labeling and identifying refrigerant piping.
 - 6. Section 23 0519 "Meters and Gages for Mechanical Piping" for thermometers and pressure gages.
 - 7. Section 23 0900 "Instrumentation and Control for HVAC" for thermostats, controllers, automatic-control valves, and sensors.
 - 8. Section 23 8126 "Split-System Heat Pump Units" for equipment.

1.3 SUBMITTALS

- A. Product Data: For each type of refrigerant piping specialty indicated.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and equipment.
 - 1. Shop Drawing Scale: 1/4-inch equals 1 foot.
 - 2. Refrigerant piping indicated on drawings is schematic only. Size piping and design the actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes, to ensure proper operation and compliance with warranties of connected equipment.
- C. Welding Certificates: Copies of certificates for welding procedures and personnel.
- D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

- E. Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals specified in Division 1.
- F. Submit refrigerant documentation with refrigerant type and weight added for each system.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX; "Welding and Brazing Qualifications."
- B. ASHRAE Standard: Comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
- C. ASME Standard: Comply with ASME B31.5, "Refrigeration Piping."

1.5 COORDINATION

- A. Coordinate layout and installation of refrigerant piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe sleeve installations for foundation wall penetrations.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.
- D. Coordinate pipe sleeve installations for penetrations in exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Section 07 8413 "Penetration Firestopping" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
- E. Coordinate pipe fitting pressure classes with products specified in related Sections.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Refrigeration Oil Test Kits: Two each, containing everything required to conduct one test.
 - 2. Refrigerant: Two containers each, with 20 lb of refrigerant.
 - 3. Filter-Dryers: Three of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Refrigerants:
 - a. Allied Signal, Inc./Fluorine Products; Genetron Refrigerants.
 - b. DuPont Company; Fluorochemicals Div.
 - c. Elf Atochem North America, Inc.; Fluorocarbon Div.
 - d. ICI Americas Inc./ICI KLEA; Fluorochemicals Bus.
 - 2. Refrigerant Specialties:

- a. Climate & Industrial Controls Group; Parker-Hannifin Corp.; Refrigeration & Air Conditioning Division.
- b. Danfoss Electronics, Inc.
- c. Emerson Electric Company; Alco Controls Div.
- d. Henry Valve Company.
- e. Sporlan Valve Company.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B 280, Type ACR or ASTM B 88, Type L.
- B. Annealed-Temper Copper Tube: ASTM B 280, Type ACR or ASTM B 88, Type K.
- C. Wrought-Copper Fittings: ASME B16.22.
- D. Wrought-Copper Unions: ASME B16.22.
- E. Solder Filler Materials: ASTM B32. Use alloy HB solder to join copper socket fittings on copper pipe.
- F. Brazing Filler Metals: AWS A5.8, Classification BAg (cadmium free silver alloy) for bronze fittings and Type BcuP (copper-phosphorous alloy) for copper fittings.
- G. Flexible Connectors: 500-psig minimum operating pressure; seamless tin-bronze core, high-tensile bronze-braid covering, and solder-joint end connections; dehydrated, pressure tested, minimum 7 inches long

2.3 REFRIGERANT PIPING SPECIALTIES

- A. Moisture/Liquid Indicators: 500-psig maximum working pressure and 200 deg F operating temperature; all-brass body with replaceable, polished, optical viewing window with color-coded moisture indicator; with solder-end connections.
- B. Permanent Filter-Dryer: 350-psig maximum operating pressure and 225 deg F maximum operating temperature; steel shell and wrought-copper fittings for solder-end connections; molded-felt core surrounded by desiccant.

2.4 REFRIGERANTS

- A. ASHRAE 34, match refrigerant types specified for equipment in other Division 23 sections.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Aboveground: Type ACR drawn-copper tubing or Type L drawn-copper tubing and wrought copper fittings with brazed or soldered joints.

3.2 SPECIALTY APPLICATIONS

- A. Install moisture-liquid indicators in liquid lines adjacent to filter-dryers at condensing units.

- B. Install permanent filter-dryers in liquid lines at condensing units.
- C. Install flexible connectors at or near compressors.

3.3 PIPING INSTALLATION

- A. Install refrigerant piping according to ASHRAE 15. Refrigerant relief valves and its associated discharge to atmosphere to be located outdoors in accordance with ASHRAE 15.
- B. Basic piping installation requirements are specified in Section 23 0500 "Common Work Results for Mechanical."
- C. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- D. Arrange piping to allow inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection.
- E. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- F. Belowground, install copper tubing in protective PVC conduit. Vent conduit outdoors.
- G. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.
- H. Slope refrigerant piping as follows:
 - 1. Install horizontal suction lines with a uniform slope downward to compressor.
 - 2. Install traps and double risers to entrain oil in vertical runs.
 - 3. Liquid lines may be installed level.
- I. Install unions to allow removal of solenoid valves, pressure-regulating valves, and expansion valves and at connections to compressors and evaporators.
- J. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.
- K. Hanger, support, and anchor products are specified in Section 23 0529 "Hangers and Supports for Mechanical Piping and Equipment."
- L. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe rollers for multiple horizontal runs 20 feet or longer, supported by a trapeze.
 - 4. Spring hangers to support vertical runs.
- M. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.

4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.

N. Support vertical runs at each floor.

3.4 PIPE JOINT CONSTRUCTION

- A. Braze and solder joints according to Section 23 0500 "Common Work Results for Mechanical."
- B. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during soldering and brazing to prevent scale formation.

3.5 FIELD QUALITY CONTROL

- A. Test and inspect refrigerant piping according to ASME B31.5, Chapter VI.
 1. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure.
 2. Test high- and low-pressure side piping of each system at not less than the lower of the design pressure or the setting of pressure relief device protecting high and low side of system.
 - a. System shall maintain test pressure at the manifold gage throughout duration of test.
 - b. Test joints and fittings by brushing a small amount of soap and glycerin solution over joint.
 - c. Fill system with nitrogen to raise a test pressure of 300 psig (for R-410A) or 150 psig (for R-134A) or higher as required by authorities having jurisdiction, for minimum of 12 hours.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.6 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of the conditioned air controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 1. Check compressor oil level above center of sight glass.
 2. Open compressor suction and discharge valves.
 3. Open refrigerant valves, except bypass valves that are used for other purposes.
 4. Check compressor-motor alignment, and lubricate motors and bearings.

3.7 CLEANING

- A. Before installing copper tubing other than Type ACR, clean tubing and fittings with trichloroethylene.

- B. Replace core of filter-dryer after system has been adjusted and design flow rates and pressures are established.

3.8 SYSTEM CHARGING

- A. Charge system using the following procedures:
 1. Install core in filter-dryer after leak test but before evacuation.
 2. Evacuate entire refrigerant system with a vacuum pump to a vacuum of 350 micrometers for a 1 hour timeframe. If pressure rises, break vacuum with clean nitrogen. After 1 hours, evacuate down to 200,000 micrometers for 15 minutes. Break vacuum with clean nitrogen. Evacuate down to 350 micrometers for 1 hours. If vacuum holds, system is ready for charging.
 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 4. Charge system with a new filter-dryer core in charging line. Provide full-operating charge.

END OF SECTION

SECTION 23 2500

HVAC WATER TREATMENT

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. This Section includes water-treatment systems for the following:
 - 1. Chilled-water piping (closed-loop system).
- B. This section also includes glycol.
- C. Related Sections include the following:
 - 1. Section 22 1116 "Domestic Water Piping" for domestic water piping cleaning and sterilization.
 - 2. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - a. Section 01 9113 "General Commissioning Requirements."
 - b. Section 23 0800 "Commissioning of Mechanical Systems."

1.3 GENERAL SCOPE OF WORK

- A. Proposals are requested from qualified Contractors to provide a Full Service Water Treatment Program for the new chilled water system within this building. These services shall include, but not be limited to, technical expertise, laboratory, delivery and other services, including the installation of any required water treatment equipment needed.
- B. The Contractor will be required to provide a full service water treatment program, with a service technician bonded to the primary water treatment Contractor. The water treatment program shall prevent scale formation, minimize corrosion, control biological growths and prevent any foreign suspended material from accumulating in the systems.
- C. As a minimum, the Contractor shall have a qualified representative make a service call to the building once every month to perform service, review log sheets, answer questions and make any changes in the water treatment program as needed to all systems covered under this Full Service Agreement with the Owner. Owner's personnel WILL NOT fill chemical feed tanks for the Contractor.
- D. Full Service shall Include:
 - 1. Provision and application of chemicals to the specified systems.
 - 2. Extraction and analysis of water samples, with written report.
 - 3. Other technical and laboratory services, including related supervision as herein described.
 - 4. Water treatment recommendations as required and action taken.
 - 5. Training of necessary personnel.

1.4 DEFINITIONS

- A. PPM: Parts per million.

1.5 CHEMICAL FEED SYSTEM DESCRIPTION

- A. Closed-Loop System: One bypass feeder on each system with isolating and drain valves downstream from circulating pumps, unless otherwise indicated.
 - 1. Introduce chemical treatment through bypass feeder when required or indicated by test.
- B. Open-Loop, Condenser Water Piping: Pump sequestering agent and corrosion inhibitor from solution tank into condenser water supply to tower. Use agitator as required.
 - 1. Intermittently feed biocide to condenser water to achieve a toxic level of the chemical to kill the organism present.
 - a. Two biocides and associated feed systems.
 - 2. Change biocides periodically to avoid chemical immunity.
 - 3. Activate chemical solution pump from water meter in makeup water line to cooling tower when condenser water pumps are running.
 - 4. Automatically feed chemical with electronic solid-state controllers.
 - 5. Deactivate solution pump and signal alarm by a liquid-level switch in each solution tank on low chemicals.

1.6 PERFORMANCE REQUIREMENTS

- A. Maintain water quality for HVAC systems that controls corrosion and build-up of scale and biological growth for maximum efficiency of installed equipment without posing a hazard to operating personnel or the environment.
- B. Base chemical treatment performance requirements on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. All chemicals proposed for use in this water treatment program shall meet all regulations of the Food and Drug Administration, the United States Environmental Protection Agency and the Maryland State Department of Water Resources.
- D. Closed System: Maintain system essentially free of scale, corrosion, and fouling to sustain the following water characteristics:
 - 1. pH: 8.0 to 9.5
 - 2. Chilled Water Corrosion Inhibitors: 50 to 100 ppm Molybdate.
 - 3. Tolytriazole: 3 to 6 ppm
 - 4. Dispersant: As needed

1.7 SUBMITTALS

- A. Product Data: Include rated capacities; water-pressure drops; shipping, installed, and operating weights; and furnished products listed below:
 - 1. Pumps.
 - 2. Chemical solution tanks.
 - 3. Agitators.
 - 4. Control equipment and devices.
 - 5. Test equipment.

6. Chemicals.
 7. Filters.
 8. Chemical feeders.
 9. Material Safety Data Sheets.
- B. Shop Drawings: Detail equipment assemblies indicating dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Wiring Diagrams: Detail power and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.
- D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
1. Legionella Test Reports: Indicate legionella bacteria count per milliliter.
- E. Pipe Cleaning Reports.
- F. Maintenance Data: For pumps, agitators, filters, system controls, and accessories to include in maintenance manuals specified in Division 1.
- 1.8 QUALITY ASSURANCE
- A. Installer Qualifications: An experienced installer who is an authorized representative of the chemical treatment manufacturer for both installation and maintenance of chemical treatment equipment required for this Project.
- B. 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.
- 1.9 CHEMICAL IDENTIFICATION, HANDLING AND STORAGE
- A. The Contractor shall post in one prominent location, complete and updated Material Safety Data Sheets (MSDS) that meet the OSHA hazardous communication standard adjacent to each chemical feed station.
- B. The Contractor must maintain a 24 hour, 7 day a week emergency response manned by employees who can be called for emergency information regarding chemical spills and/or accidents involving the Contractor's products. The Contractor shall submit the emergency phone number and a sample of documentation outlining instructions for reporting accidents and chemical spills.
- C. All chemicals shall be transported, delivered and installed by the Contractor to the building. Chemicals shall be provided in portable containers properly labeled and marked in accordance with all Federal, State and EPA regulations. University of Maryland personnel will not handle chemicals. Therefore, the Contractor must deliver all chemicals to the point of use. It is the Contractor's responsibility to transfer and apply all chemicals to the systems at each site.

1.10 MAINTENANCE

- A. Scope of Service: Provide chemicals and service program for maintaining optimum conditions in the circulating water for inhibiting corrosion, scale, and organic growths in the cooling, chilled-water piping, heating hot-water piping, piping, condenser water piping and equipment. Services and chemicals shall be provided for a period of two years from date of Substantial Completion, including the following:
1. Initial water analysis and recommendations.
 2. Startup assistance.
 3. Monthly field service and consultation for each system.
 - a. Adjust feeding equipment, apply chemicals, obtain and analyze samples, and regulate bleed-off of open systems to maintain specified performance requirements.
 4. Monthly customer report charts and log sheets for each system.
 - a. Indicate which systems were serviced, and then test results.
 5. Laboratory technical assistance.
 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.
 7. Monthly Legionella Test: Cooling tower water, conducted in a certified laboratory.

1.11 REPORTS

- A. The Contractor shall submit reports to the University of Maryland, HVAC Supervisors on an ongoing basis and at the time of each visit. Each report shall contain the following information:
1. Contractors test results. Test shall be taken for all systems in service at the time of the Contractor's visit. These shall contain all applications test results specified in the chemical residual section of these specifications and or recommended by the manufacturer of the chemical. These results shall be reported in the same units used in the residual section of these specifications.
 2. Results of inspection of water treatment equipment for proper operation.
 3. Inventory of on-hand chemicals for all systems treated.
 4. Water meter readings for all systems with meter.
 5. Notation of the overall condition of the systems, chemical feed equipment and anything else that may affect the performance of the treatment program.
 6. Note and recommend corrective action for any deficiencies determined by the Contractors test and visual inspection of the systems.
 7. Notation of any adjustments made to the system.
 8. One copy of the report shall be delivered, discussed and signed off on by the HVAC Manager and one copy shall be left at the inspection/test site. The HVAC Manager's copy must be delivered within five days of the test date.

1.12 EMERGENCY SERVICE

- A. The Contractor shall make an emergency job site visit(s) as required by the Owner/Agent to address problems involving water treatment. This shall occur within four (4) hours after the initial call, on 24 hours a day, 7 days a week basis, including holidays. The Contractor shall provide designated Owner/Agent personnel with emergency telephone numbers to call after hours, on weekends and holidays.

1.13 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Chemicals: Furnish quantity equal to 10 percent of amount initially installed.
2. Filter Bags: 5 of each listed below.
 - a. 5-micron
 - b. 20-micron
3. Glycol: Furnish 50 gallons.

1.14 COORDINATION

- A. Coordinate field piping requirements.
- B. Coordinate field wiring requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the listed manufacturer, no substitutions allowed:
 1. HVAC Water-Treatment Products:
 - a. Bond Water Technologies.
 - b. Nalco Chemical Co.
 - c. Barclay.
 - d. Chem Aqua.

2.2 CHEMICAL FEEDING EQUIPMENT

- A. Bypass Feeders: Cast iron or steel, for introducing chemicals into system; with 5-micron and 20-micron ring-top filter bags, stainless steel dissolving basket for filter bag support, support legs, wide mouth (minimum 2-inch) opening on top, cap, air-release valve on top, drain valve on bottom, and recirculating shutoff valves on sides. Piping, valves, specialties, and insulation shall be the same specified for the system they serve.
 1. Capacity: 5 gal.
 2. Working Pressure: 125 psig.
- B. Positive-Displacement Pump: Provide either diaphragm or piston style.
 1. Diaphragm Style: Simplex, self-priming, rated for intended chemical with 25 percent safety factor for design pressure and temperature.
 - a. Adjustable flow rate.
 - b. Thermoplastic construction.
 - c. Fully enclosed, continuous-duty, 120-V, 60-Hz, single-phase motor. Comply with requirements in Section 23 0513 "Common Motor Requirements for Mechanical Equipment."
 - d. Built-in relief valve.
 2. Piston Style: Metal and thermoplastic construction.
 - a. Fully enclosed, continuous-duty, 120-V, 60-Hz, single-phase motor. Comply with requirements in Section 23 0513 "Common Motor Requirements for Mechanical Equipment."
 - b. Built-in relief valve.
- C. Chemical Solution Tanks: Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with graduated markings.
 1. Molded fiberglass cover with recess for mounting pump, agitator, and liquid-level switch.
 2. Capacity: 30 gal. or 50 gal.

- D. Agitator: Direct drive, 1750 rpm, mounted on tank with angle adjustment.
 - 1. Fully enclosed, continuous-duty, 120-V, 60-Hz, single-phase motor. Comply with requirements in Section 23 0513 "Common Motor Requirements for Mechanical Equipment."
 - 2. Stainless-steel clamp and motor mount, with stainless-steel shaft and propeller.
- E. Liquid-Level Switch: Polypropylene housing, integrally mounted PVC air trap, receptacles for connection to metering pump, and low-level alarm.
- F. Cold Water Meters: Electrical contacting head water meter. Meter shall have bronze body with unitized measuring chamber. Meter shall include an impeller for measuring flow and shall provide a dry contact signal for interfacing with a pulse-type timer.
 - 1. Transmitter: Metal enclosure, pulse conversion to 4-20 mA signal proportional to flow rate, factory calibrated, plus or minus 0.5 percent accuracy, plus or minus 0.1 percent of full scale repeatability, 115 VAC, maximum 10 VA. Coordinate output with building automation system specified in Section 23 0900 "Instrumentation and Control for HVAC."
- G. Solenoid Valves: Forged-brass body, globe pattern, and general-purpose solenoid enclosure with 120-V, continuous-duty coil.
- H. Electronic Timers: 150-second and 5-minute ranges, with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
- I. Chemical Tubing: Schedule 0, PVC with solvent-cement joints; or polypropylene tubing with heat fusion.
- J. Plastic Ball Valves: Rigid PVC or CPVC body, integral union ends, and polytetrafluoroethylene seats and seals.
- K. Plastic-Body Strainer: Rigid PVC or CPVC with cleanable stainless-steel strainer element.

2.3 CHEMICAL TREATMENT TEST EQUIPMENT

- A. Test Kit: Manufacturer recommended equipment and chemicals, in a carrying case, for testing pH, total dissolved solids, dissolved oxygen, biocount, chloride, and total alkalinity and for calcium hardness field tests. Provide two complete test kits.

2.4 CHEMICALS

- A. Furnish chemicals recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment.
- B. System Cleaner: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.
 - 1. Quantity: As required to clean system.
- C. Biocide: Chlorine release agents or microbiocides.
 - 1. Quantity: As required to provide specified water treatment for system operation of 12 months per year.
- D. Closed-Loop, Water Piping Chemicals: Sequestering agent to reduce deposits and adjust pH, corrosion inhibitors, and conductivity enhancers.

1. Quantity: As required to provide specified water treatment for system operation of 12 months per year.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to maintain the water quality as specified in "Performance Requirements" Article.

3.2 INSTALLATION

- A. Install treatment equipment level and plumb.
- B. Add cleaning chemicals as recommended by manufacturer.
 1. Cleaning shall be witnessed by the Construction Manager.
 2. Closed recirculating systems shall be filled and sufficient detergent and dispersant added to remove all dirt, oil, and grease. System shall be circulated for at least 24 hours after which drain valve at the lowest point shall be opened and allowed to bleed while the system continues to circulate. The automatic make-up valve shall be checked to be sure it is operating. Bleeding shall continue until water runs clear and all detergent is removed. A sample of water shall be tested and, if pH exceeds the pH of the make-up water, draining shall be resumed.
 3. Before adding cleaning chemical to the closed system, handling coils and fan coil units should be isolated by closing the inlet and outlet valves and opening the by-pass valves, to prevent dirt and solids from lodging in the coils.
 4. After chemical cleaning is satisfactorily completed, open the inlet and outlet valves to each coil and close the bypass valves. Clean strainers.
 5. Prepare report and submit for record.
- C. Install glycol in drycooler loop system.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Install bypass feeder piping across circulating pump suction and discharge piping.
- D. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.
- E. Ground equipment.
 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to perform startup service.

1. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
- B. Test chemical feed piping and operation as follows:
1. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 2. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 3. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 4. 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 test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 5. Test glycol feeder and automatic feed based on pressure setpoint.
 6. Repair leaks and defects with new materials and retest piping until satisfactory results are obtained.
 7. Test glycol concentration upon turnover of system to owner at substantial completion.
 8. Prepare test reports, including required corrective action.
- C. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
1. Section 01 9113 "General Commissioning Requirements".

3.5 ADJUSTING

- A. Occupancy Adjustments: Within 12 months of Substantial Completion, perform two separate water analyses to prove that automatic chemical feed systems are maintaining water quality within performance requirements specified in this Section. Perform analyses at least 60 days apart. Submit written reports of water analysis.

3.6 DEMONSTRATION

- A. Refer to Section 01 7350 "Demonstration and Training" for training requirements for Owner's maintenance personnel and building occupants.
- B. The Contractor shall furnish a qualified water treatment technician or engineer, bonded to the primary water treatment Contractor, to instruct designated Owner personnel during the contract year(s), commencing the second month after the start of the contract. Subsequent training sessions shall be provided should the Owner require it. The instruction shall include a minimum of four (4) hours of classroom training and four (4) hours of field training per contract period and shall cover, but not be limited to the following topics:
1. Fundamentals of Water Treatment
 2. Chemical and Methods of Use
 3. Procedure for Taking Samples
 4. Procedures, Operations and Testing

END OF SECTION

SECTION 23 3113

METAL DUCTS

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. This Section includes metal ducts for supply, return, outside, relief, transfer, and exhaust air-distribution systems in pressure classes from minus 10-inch wg to plus 10-inch wg. Metal ducts include the following:
 - 1. Rectangular ducts and fittings.
 - 2. Single-wall, round and flat oval, spiral-seam ducts and formed fittings.
 - 3. Double-wall, round and flat oval, spiral-seam ducts and formed fittings.
 - 4. Duct liner.
- B. Related Sections include the following:
 - 1. Section 23 0130.51 "HVAC Air-Distribution System Cleaning" for duct cleaning requirements.
 - 2. Section 23 0500 "Common Work Results for Mechanical" for additional general requirements.
 - 3. Section 23 0901 "Air Measuring Stations" for air measuring stations furnished under Section 23 0900, installed under this section.
 - 4. Section 23 3300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, flexible connectors, and flexible ducts.
 - 5. Section 01 8113 "Sustainable Design Requirements" for additional requirements.
 - 6. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - a. Section 01 9113 "General Commissioning Requirements."

1.3 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.4 SUBMITTALS

- A. Product Data: Manufacturer's technical literature for each specified product.
- B. Shop Drawings: CAD-generated and drawn to minimum 1/4 inch equals 1-foot scale. Shop Drawings shall be prepared with same building orientation as the construction documents. Show fabrication and installation details for metal ducts.
 - 1. Include shop drawings for all ductwork provided on this project.

2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
3. Duct layout indicating sizes and pressure classes.
4. Elevations of top and bottom of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Penetrations through fire-rated and other partitions.
8. Equipment installation based on equipment being used on Project.
9. Duct accessories, including access doors, panels, dampers, and air flow measuring devices.
10. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.
11. Refer to Section 23 0500 "Common Work Results for Mechanical" for coordination drawing requirements.

C. Welding certificates.

D. Field quality-control test reports.

E. For each duct system, the gauge, material, joint type, seam type, and reinforcement to be provided for each duct size.

F. No ductwork shall be fabricated or installed until shop drawings are approved.

G. Certificates: For certification required in "QUALITY ASSURANCE" Article.

H. LEED Submittals:

1. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, demonstrating compliance with low-emitting materials requirements.
2. Credit EQ 4.2: Manufacturers' product data for paints and coatings, demonstrating compliance with low-emitting materials requirements.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code-Steel," for hangers and supports and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

C. Duct Cleanliness: Duct Cleanliness for New Construction (SMACNA 2000).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles below where titles introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible, Third Edition," and all addenda for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653 and having G60 (for circular ducts) and G90 (for rectangular ducts) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view in finished spaces, suitable for field painting.
- C. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- D. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.
- E. Stainless Steel: ASTM A 480/A 480M, Type 304, and having a No. 2D finish for concealed ducts and No. 4D finish for exposed ducts.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- G. Tie Rods: Galvanized steel, 3/8-inch minimum diameter.

2.3 DUCT LINER

- A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.
 - 1. Manufacturers:
 - a. CertainTeed Corp.; Insulation Group.
 - b. Johns Manville International, Inc.
 - c. Knauf Fiber Glass GmbH.
 - d. Owens Corning.
 - 2. Materials: ASTM C 1071, Type I (flexible) for rectangular ductwork and Type II (rigid) for round ductwork; EPA registered anti-microbial surface coating which will not support the growth of bacteria or fungus; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.
 - a. Thickness: 1-inch, unless indicated otherwise on drawings.
 - b. Thermal Conductivity (k-Value): 0.24 at 75 deg F mean temperature.
 - c. Noise Reduction Coefficient: 0.70 at 1-inch thickness. Sound absorption coefficients as tested on an Acoustical Materials Association Standard A-type mounting in accordance with ASTM Standard C423-90:

MINIMUM SOUND ABSORPTION COEFFICIENTS FOR DUCT LINING							
Octave Band Center Frequency (Hz)							
Lining Thickness	125	250	500	1000	2000	4000	8000
1"	.09	.19	.48	.65	.78	.83	.90
2"	.22	.47	.76	.89	.89	.91	.95

- d. Density: Minimum 1.5 pcf.
- e. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

- f. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - 1) Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
 - 2) Manufacturers:
 - a) Foster 85-60/85-20.
 - b) Childers CP-127/CP-82.
- g. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
 - 1) Tensile Strength: Indefinitely sustain a 50-lb- tensile, dead-load test perpendicular to duct wall.
 - 2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
 - 3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.
- h. Round and flat oval duct liner shall be preformed or round board specifically listed for round and flat oval duct applications.

2.4 SEALANT MATERIALS

- A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
- B. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
- C. Rolled Sealant Tape: 3 inches wide for slip joints, 6 inches wide for prefabricated slide-on joints, and formed on flanges; 2 mil aluminum bonded to gray butyl adhesive minimum 30 mils thick, 17 lbs per linear inch peel strength, 720 psi tensile strength, negative 20 deg. F to plus 200 deg. F service temperature, weather resistance per ASTM G-53 @ 2000 hours QUV, suitable for up to 10 inch water gage SMACNA pressure class and all seal classes.
- D. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
- E. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
 - 1. Manufacturers:
 - a. Foster 32-19 (non-fibrated); 32-17 (fibrated).
 - b. Childers CP-146 (non fibrated); CP-148 (fibrated).
- F. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.
- G. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- H. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
 - 1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 - 2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
 - 3. Vibration isolators are specified in Section 23 0548 "Mechanical Vibration Control."
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
 - 3. Risers: Supports along the long dimension of the duct cross-section, in accordance with SMACNA Manual, Figure 4-7.
- E. Round Duct in Finished Spaces: Hangers around full perimeter of ducts with threaded rod supports.

2.6 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals. Fabricate ductwork to be free from vibration, rattle or drumming under all operating conditions.
 - 1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 - 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
 - 3. Transverse Joints: Utilize prefabricated slide-on joints or formed-on flanges.
 - a. Slip-and-Drive Joints may be utilized for transfer ducts, at Contractor's option.
 - 4. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
- B. Prefabricated Slide-on Joints: Constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, joining methods, and joint reinforcement.
 - 1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Nexus, Inc.
 - c. Quickduc, Inc.
 - d. Ward Industries, Inc.

- C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards-- Metal and Flexible," Figure 1-4, joints T-25a or T-25b (TDC or TDF) using corner, bolt, cleat, and gasket details.
 - 1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Lockformer.
 - 2. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.
 - D. Requirements for Prefabricated Slide-on Joints and Formed-on Flanges:
 - 1. Minimum sheet metal gauges shall conform to both Rectangular Duct Reinforcement Tables 1-3 through 1-9 and Transverse Joint Reinforcement Table 1-12.
 - 2. Cleats or clips as manufactured for the specific purpose of joining adjacent flanges shall be utilized in conjunction with transverse joints; sheet metal screws alone are not acceptable for joining flanges.
 - E. Restrictions for Use of Tie Rods:
 - 1. Tie rods or other type of intermediate duct reinforcement shall not be used in ducts with longest side less than 37 inches.
 - 2. Where tie rod connections penetrate ductwork, neoprene backed galvanized washers shall be used to seal penetrations airtight.
 - 3. Where tie rods are in sound lined ductwork, seal edges of sound lining penetrations with sound lining adhesive.
 - 4. Tie rods at each joint and between joint and mid span shall align to minimize air turbulence.
 - F. Rectangular Duct Fittings:
 - 1. Fabricate elbows, transitions, offsets, branch connections, etc., in accordance with SMACNA manual Figures 2-1 through 2-10 and the following:
 - a. Rectangular elbows shall be Figure 2-2 Type RE-2 with turning vanes. Vanes shall be only double radius type Figures 2-3 and 2-4.
 - b. Radius elbows shall be Figure 2-2 Type RE-1 only.
 - c. Branch connections shall be 45-degree entry type only.
 - d. Transitions and offsets shall follow Figure 2-7 and where space permits shall slope a maximum of 15 degrees, unless otherwise indicated on drawings.
 - G. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.
- 2.7 APPLICATION OF LINER IN RECTANGULAR DUCTS
- A. Adhere a single layer of indicated thickness of duct liner with 100 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 - B. Apply adhesive to all transverse edges of liner.
 - C. Butt transverse joints without gaps and coat joint with adhesive.
 - D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

- E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
- F. Apply adhesive coating on longitudinal seams in ducts.
- G. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
- H. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - 1. Fan discharges.
 - 2. Intervals of lined duct preceding unlined duct.
 - 3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm or where indicated.
 - 4. Branch duct taps.
 - 5. Duct access doors.
- I. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.
- J. Source Quality Control:
 - 1. Inspect ductwork for compliance with SMACNA manual and NAIMA AH116 "Fibrous Glass Duct Construction Standard." Repair or replace deficiencies. Utilize NAIMA "Fibrous Glass Duct System Installation Checklist."
 - 2. Seal ends of each duct section with plastic in the shop immediately after fabrication to keep airside surfaces clean during handling, shipping, installation, storage, etc.

2.8 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

- A. Round and Flat-Oval, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Fabricate ducts larger than 72 inches in diameter with butt-welded longitudinal seams.
 - 1. Manufacturers:
 - a. Lindab Incorporated.
 - b. McGill AirFlow Corporation.
 - c. Monroe Metal Manufacturing Company.
 - d. SEMCO Incorporated.
- B. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.
- C. Duct Joints:
 - 1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
 - 2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
 - 3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
 - 4. Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.

- a. Manufacturers:
 - 1) Ductmate Industries, Inc.
 - 2) Lindab Inc.
5. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.
 - a. Manufacturers:
 - 1) Ductmate Industries, Inc.
 - 2) McGill AirFlow Corporation.
 - 3) SEMCO Incorporated.
- D. Fitting Seams:
 1. Spot or tack welded and sealed with a specified sealant for pressure classes from minus 2-inch wg to plus 2-inch wg., unless otherwise indicated.
 2. Continuously welded for pressure classes from plus 2-inch wg to 10-inch wg., unless otherwise indicated.
- E. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts. Fittings shall be either "Lo Loss" or conical type. Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
 1. Saddle taps and bullhead tees are not acceptable.
 2. At Contractor's option, factory fabricated manifolds (one or more "Lo Loss" or conical taps permanently attached to a piece of spiral pipe in the factory) may be provided.
- F. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
 1. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
 2. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
 3. Round Elbows Larger Than 14 Inches in Diameter: Fabricate gored elbows unless space restrictions require mitered elbows.
 4. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
 5. Die-Formed Elbow Construction for Sizes through 8 Inches in Diameter and All Pressures: 0.040-inch thick metal with 2-piece welded construction.
 6. Pleated Elbow Metal Thickness for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.
 7. Round Gored-Elbow Construction: Welded construction complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts. Minimum number of pieces:
 - a. 0 - 45 Degrees: 3.
 - b. 46 - 60 Degrees: 4.
 - c. 61 - 90 Degrees: 5.

8. Flat-Oval Elbow Construction: Welded construction complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," with thicknesses specified for longitudinal-seam flat-oval duct.
9. Round Mitered Elbow Construction: Welded construction complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

- G. Round fittings indicated to have sound lining shall be provided with double-wall fittings.
- H. End caps of round ductwork exposed in finished spaces shall be convex.

2.9 APPLICATION OF LINER IN ROUND DUCTS

- A. Adhere a single layer of indicated thickness of duct liner with 100 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
- B. Apply adhesive to all transverse edges of liner.
- C. Butt transverse joints without gaps and coat joint with adhesive.
- D. Preformed liner shall be slid into round duct per manufacturer's installation instructions up to size indicated by manufacturer. Linerboard listed for round duct applications shall be snap-in installation per manufacturer's instructions.
- E. Apply adhesive coating on longitudinal seams in ducts.
- F. Secure liner in accordance with manufacturer's written recommendations.
- G. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 1. Fan or terminal unit discharges.
 2. Intervals of lined duct preceding unlined duct or fittings.
 3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm (12.7 m/s) or where indicated.
 4. Branch duct taps.
 5. Duct access doors.
- H. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.
- I. At the Contractor's option, round duct indicated to have sound lining may be provided with double-wall duct.
- J. Round fittings indicated to have sound lining shall be provided with double-wall fittings.

2.10 DOUBLE-WALL DUCT AND FITTING FABRICATION

- A. Manufacturers:
 1. Lindab Inc.
 2. McGill AirFlow Corporation.
 3. Monroe Metal Manufacturer's Company.
 4. SEMCO Incorporated.

- B. Materials shall comply with LEED Credits EQ 4.1 and 4.2 for low emitting materials.

- C. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.
 1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner duct and insulation and in metal thickness specified for single-wall duct.
 2. Insulation: 1-inch- thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.
 - a. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
 3. Perforated Inner Ducts: Fabricate with 0.028-inch- thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.
 4. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.

- D. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct. Dimensions indicated are for inner ducts.
 1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner duct and insulation and in metal thickness specified for single-wall duct.
 2. Insulation: 1-inch- thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.
 - a. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
 3. Perforated Inner Ducts: Fabricate with 0.028-inch- thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.
 4. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

- A. Static-Pressure and Seal Classes: Unless otherwise indicated on the drawings, construct ducts according to the following:

DUCT SYSTEM	SMACNA PRESSURE CLASS (INCHES WG)	GAGE PRESSURE	SMACNA SEAL CLASS
Main supply ducts from AHU-1 to air devices	2"	Positive	A

DUCT SYSTEM	SMACNA PRESSURE CLASS (INCHES WG)	GAGE PRESSURE	SMACNA SEAL CLASS
Supply ducts from terminal units and fan coil units to air devices	2"	Positive	A
Relief air ductwork	2"	Positive	A
Return ductwork	3"	Negative	A
General/toilet exhaust ductwork	2"	Negative	A
Outdoor air ductwork	2"	Negative	A
Transfer ductwork	1"	Positive	None

- B. All ducts shall be galvanized steel, except as follows:
 - 1. Exhaust branch ductwork serving spaces with showers shall be aluminum.
- C. All stainless steel ductwork shall have welded joints and seams.
- D. Exposed round and flat oval supply ducts shall be double-wall construction.
- E. Exposed round and flat oval return and exhaust ducts shall be single-wall construction.
- F. All round and flat oval ducts shall be spiral lock-seam type.
 - 1. At Contractor's option, spiral lockseam duct with standing rib construction may be utilized for concealed positive low pressure (+0 to 2 inch w.g.).
 - 2. At Contractor's option, when concealed from finished spaces, up to 10 linear feet of longitudinal seam duct may be utilized in low pressure (negative 2-inch w.g. to positive 2-inch w.g.) systems, between taps and diffusers, provided longitudinal seam is sealed.

3.2 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards-Metal and Flexible," unless otherwise indicated.
- B. At Contractor's option, round and flat oval ductwork may be provided in lieu of rectangular duct in equivalent free area sizes where space permits.
- C. Install round and flat oval ducts in lengths as long as possible to reduce joints.
- D. Install ducts with fewest possible joints.
- E. Install fabricated fittings for changes in directions, size, and shape and for connections.
- F. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

- G. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- J. Conceal ducts from view in finished spaces with suspended ceilings. Do not encase horizontal runs in solid partitions unless specifically indicated.
- K. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- L. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- M. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- N. Sleeves, Generally: Install minimum 22-gauge sleeves between duct or duct insulation and wall, floor, or ceiling penetrations.
 - 1. Size sleeve to provide annular space specified or detailed on the drawings.
 - 2. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved sealant for gypsum board assemblies.
- O. Floor, Wall, and Partition Penetrations, Generally: Seal annular space between sleeves and duct or duct insulation, using joint sealants appropriate for size, depth, and location of joint.
 - 1. Where sleeves are exposed in finished spaces, provide 1-inch wide perimeter flange (including corners) on both sides of wall.
 - 2. There shall be no direct contact of duct with sleeves.
 - 3. Where ductwork passes through a wall, floor or ceiling, there shall be a clear annular space of 1" between the duct or duct insulation and sleeve. After all of the ductwork is installed the Contractor shall check the clearance, pack the voids full depth with mineral fiber batt insulation and caulk both ends with a non-aging, non-hardening sealant backed by a polyethylene foam rod or permanently flexible firestop material.
- P. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions or exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- Q. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions or exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Section 23 3300 "Air Duct Accessories." Firestopping materials and installation methods are specified in Section 07 8413 "Penetration Firestopping." Provide sleeves as detailed or required by damper manufacturer.
- R. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."
 - 1. Cleanliness Level: Advanced.

2. Seal ends of ductwork and air devices with plastic as they are installed. In no case shall a duct be left open ended.
 3. Once system is placed in operation, provide temporary filters at each return air inlet and at each AHU until final acceptance by the Owner. Refer to Section 23 4100 "Particulate Air Filtration."
 4. If cleanliness level is not achieved, clean all ductwork.
- S. Ductwork shall be cleaned after construction is completed, prior to building turnover. Refer to Section 23 0130.51 for duct cleaning requirements.
- T. Paint interiors of metal ducts that do not have duct liner, for 24 inches upstream and downstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9 painting Sections.
- U. Paint all ductwork exposed to view in public spaces. Provide appropriate galvanized duct finish. Fully remove any fabrication labels or other items from the native finish prior to cleaning, preparing, and finishing the duct with paint. Provide small mock-up of painted ductwork for approval by architect.

3.3 SEAM AND JOINT SEALING

- A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.
1. For pressure classes 2-inch wg and lower, seal transverse joints.
 2. See paragraph 3.1 for duct seal classes.
- B. Seal ducts before external insulation is applied.
- C. For ducts without external insulation in finished spaces, utilize tape sealing system.
- D. For TDC/TDF and formed-on flange joints, provide sealant along exterior of joints (in addition to the sealant on the flange faces).

3.4 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
1. Exterior Ducts: Maximum 60 inches on center. Design to resist wind loading and up lift.
- B. Support vertical ducts at maximum intervals of 16 feet and at each floor.
- C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- D. Install concrete inserts before placing concrete.
- E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

- F. Support exterior ductwork in accordance with requirements stated in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
 - 1. Support Spacing: maximum 5 feet.
 - 2. Support Material: galvanized steel.
 - 3. Bottom elevation of Exposed Ductwork on Roof: Minimum 5 feet, to facilitate roof access.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Section 23 3300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
 - 1. Test ALL ductwork.
 - 2. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 3. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - 4. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round ducts, Leakage Class 6 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures), Leakage Class 6 for rectangular ducts in pressure classes from 2- to 3-inch wg, and Leakage Class 3 for rectangular ducts in pressure classes from 4- to 10-inch wg.
 - 5. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.
 - 6. Keep ducts free of audible leaks that are detectable in finished spaces.
 - 7. Notify Owner's representative and testing and balancing contractor (Section 23 0593 "Testing, Adjusting, and Balancing for "HVAC"), who shall witness tests, at least 48 hours in advance.
 - 8. Record leakage testing results on reproduced forms from the SMACNA HVAC Air Duct Leakage Test Manual. Submit results of tests to Architect within one week after completion. Maintain a record set of ductwork drawings (on site) with sections of tested ductwork indicated by shading; Commissioning Agent shall periodically inspect record duct testing drawings throughout the construction process.
 - 9. Perform testing prior to installing insulation systems.
- B. Installation of Lined Ductwork:
 - 1. Verify lined duct is free from tears or punctures in facing as each duct section is installed. Repair following NAIMA standard procedures.
 - 2. Utilize NAIMA "Fibrous Glass Duct System Installation Checklist" as ductwork is installed.
 - 3. The Owner or their authorized representative intends to inspect the installation of lined duct throughout the construction process to verify conformance with fabrication and installation requirements.

- C. Most of the mechanical systems are included in the Commissioning Program. Refer to Section 01 9113 "General Commissioning Requirements" for requirements associated with Commissioning.

3.7 EXTENT OF SOUND LINING

- A. Sound lining for duct systems shall be provided where indicated on drawings.
- B. All duct sizes indicated on drawings are airside sizes. Increase sheet metal size as required to accommodate sound lining.

END OF SECTION

SECTION 23 3300
AIR DUCT ACCESSORIES

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. This Section includes the following:
1. Volume dampers.
 2. Backdraft dampers.
 3. Fire dampers.
 4. Smoke dampers.
 5. Combination fire and smoke dampers.
 6. Duct silencers.
 7. Turning vanes.
 8. Duct-mounting access doors.
 9. Round takeoff fittings.
 10. Flexible connectors.
 11. Flexible ducts.
 12. Duct accessory hardware.
- B. Related Sections include the following:
1. Section 01 8113 "Sustainable Design Requirements" for additional requirements.
 2. Section 23 0700 "Mechanical Insulation" for field-applied acoustical jacketing requirements to air terminal units and laboratory air terminal units located within noise sensitive areas.
 3. Section 23 0900 "Instrumentation and Control for HVAC" for motor-operated dampers.
 4. Section 28 3111 "Digital Addressable Fire Alarm System" for duct-mounting fire and smoke detectors.
 5. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - a. Section 01 9113 "General Commissioning Requirements."

1.3 SUBMITTALS

- A. Product Data: For the following:
1. Volume dampers.
 2. Fire dampers.
 3. Smoke dampers.
 4. Combination fire and smoke dampers.
 5. Duct silencers.
 6. Turning vanes.
 7. Duct-mounting access doors.
 8. Round takeoff fittings.
 9. Flexible connectors.

10. Flexible ducts.
 11. Motor ratings and electrical characteristics, plus motor and electrical accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Special fittings.
 2. Manual-volume damper installations.
 3. Fire-damper, smoke-damper, and combination fire- and smoke-damper installations, including sleeves and duct-mounting access doors.
 4. Wiring Diagrams: Power, signal, and control wiring.
- C. LEED Submittals:
1. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, demonstrating compliance with low-emitting materials requirements.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Source Limitations: Duct Silencers: Obtain duct silencers through one source from a single manufacturer with resources to provide products complying with requirements indicated without delaying the Work.
- C. Manufacturer Qualifications: Duct Silencers: A firm experienced in manufacturing duct silencers similar to those indicated for this Project and with a record of successful in-service performance for a minimum of 5 years.

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles below where titles introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

- C. Stainless Steel: ASTM A 480/A 480M.
- D. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 3/8-inch minimum diameter.

2.3 VOLUME DAMPERS

- A. Manufacturers:
 - 1. Air Balance, Inc.
 - 2. American Warming and Ventilating.
 - 3. Flexmaster U.S.A., Inc.
 - 4. Greenheck Fan Corp.
 - 5. McGill AirFlow Corporation.
 - 6. Metropolitan Air Technology.
 - 7. Nailor Industries Inc.
 - 8. Pottorff
 - 9. Ruskin Company.
- B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
- C. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
- D. Standard Volume Dampers: Multiple- or single-blade, opposed-blade design as indicated, standard leakage rating, and suitable for horizontal or vertical applications.
 - 1. Steel Frames: Hat-shaped, galvanized or stainless (match duct construction) sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 - 2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized or stainless (match duct construction) sheet steel.
 - 3. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 - 4. Blade Axles: Galvanized steel or Stainless steel (match duct construction).
 - 5. Bearings: Oil-impregnated bronze.
 - 6. Tie Bars and Brackets: Galvanized steel.
- E. Manual Remote Control Volume Dampers: Multiple- or single-blade, opposed-blade design as indicated with adjustment cable, standard leakage rating, and suitable for horizontal or vertical applications, as manufactured by Metropolitan Air Technology LLC model #RT-200 (rectangular) and RT-250 (round).
 - 1. Steel Frames: Hat-shaped, galvanized or stainless (match duct construction) sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with

- flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized or stainless (match duct construction) sheet steel.
 3. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 4. Blade Axles: Galvanized steel or Stainless steel (match duct construction).
 5. Bearings: Self lubricated nylon.
 6. Tie Bars and Brackets: Galvanized steel.
 7. Actuator:
 - a. Worm gear drive with concealed linkage.
 - b. Adjustment cable, brass plated; provide length necessary to reach actuator and associated retainers. Adjustable with standard hex nut driver.
 - c. Cable Termination: Generally, mounted in linear diffuser plenums. Provide recessed ceiling cup or square air device mounted where installation in linear diffuser plenum is not possible. Recessed ceiling cup size, finish, and location shall be as approved by Architect.
- F. Jackshaft: 1/2-inch- diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.
- G. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.4 FIRE DAMPERS

- A. Manufacturers:
1. Air Balance, Inc.
 2. Greenheck Fan Corp.
 3. Nailor Industries Inc.
 4. Portoff
 5. Prefco Products, Inc.
 6. Ruskin Company.
- B. Fire dampers shall be labeled according to UL 555, listed for use in static systems.
- C. Fire Rating: Minimum 1-1/2 hours.
- D. Frame: Curtain type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
1. Pressure Classes 2-inch and Less (Positive and Negative): Style B. (Blades outside of airstream.)
 2. Pressure Classes 3-inch and Greater (Positive and Negative): Style C. (Blades and frame outside of airstream.)

- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.052 or 0.138 inch thick as indicated and of length to suit application.
 - 2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Fusible Links: Replaceable link and switch package, factory installed, 165 deg F rated.
 - 1. Fire damper position shall be monitored through the BAS.

2.5 SMOKE AND COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. Nailor Industries Inc.
 - 4. Portoff
 - 5. Ruskin Company.
- B. General Description: Labeled according to UL 555S. Combination fire and smoke dampers shall be labeled according to UL 555 for 1-1/2-hour rating for dampers installed in 1-hour or 2-hour fire-rated walls.
- C. Heat Release Device for Combination Fire and Smoke Dampers: Electric sensor or thermostat, heat actuated, factory wired.
 - 1. Automatic remote reset after test.
 - 2. Manual reset after high temperature or fire.
 - 3. Release temperature: 165 deg F rated
- D. Smoke Release Device: Duct smoke detector.
 - 1. Duct smoke detectors are specified in Section 28 3100 "Fire Detection and Alarm System."
 - 2. Wiring Terminal Strip: Terminations for field wiring of duct smoke detector module to damper actuator control.
 - 3. Mounting: External to ductwork.
- E. Control Transformer: If required for control interface between release devices and damper actuator.
- F. Frame and Blades: 0.064-inch- thick, galvanized sheet steel.
- G. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.

- H. End switch: Switch package to indicate damper position, for monitoring by the building automation system.
- I. Damper Motors: Modulating and two-position action.
 - 1. Comply with requirements in Division 23 Section "Common Motor Requirements for Mechanical Equipment."
 - 2. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 3. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments.
 - 4. Outdoor Motors and Motors in Outside-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 - 5. Electrical Connection: 115 V, single phase, 60 Hz.
 - 6. Mounting: External to ductwork.

2.6 AIR HANDLING UNIT AND DUCT SILENCERS

- A. Manufacturers:
 - 1. Vibro-Acoustics.
 - 2. Dynasonic Systems, Inc.
 - 3. Industrial Noise Control, Inc.
 - 4. Price Industries.
 - 5. Ruskin Company.
 - 6. Semco.
- B. General Description: Factory-fabricated and -tested, round or rectangular silencers with performance characteristics and physical requirements as indicated.
- C. Fire Performance: Adhesives, sealants, packing materials, and accessory materials shall have fire ratings not exceeding 25 for flame-spread index and 50 for smoke-developed index when tested according to ASTM E 84.
- D. Rectangular Units: Fabricate casings with a minimum of 0.034-inch- thick, G90, solid galvanized sheet metal for outer casing and 0.028-inch- thick, ASTM A 653/A 653M, G90, perforated galvanized sheet metal for inner casing, unless otherwise noted.
- E. Round Units:
 - 1. Outer Casings:
 - a. ASTM A 653/A 653M, G90, galvanized sheet steel.
 - b. Up to 24 Inches in Diameter: 0.034 inch thick.
 - c. 26 through 40 Inches in Diameter: 0.040 inch thick.
 - d. Casings fabricated of spiral lock-seam duct may be one size thinner than that indicated.
 - 2. Interior Casing, Partitions, and Baffles:
 - a. ASTM A 653/A 653M, G90, galvanized sheet steel.
 - b. At least 0.034 inch thick and designed for minimum aerodynamic losses.
- F. Sheet Metal Perforations: 1/8-inch diameter for inner casing and baffle sheet metal.

- G. Fill Material: Inert and vermin-proof fibrous material, 4.5 pcf, packed under not less than 5 percent compression, unless indicated otherwise.
 - 1. Erosion Barrier: Fiberglass cloth or Polymer film liner.
- H. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations.
 - 1. Do not use nuts, bolts, or sheet metal screws for unit assemblies.
 - 2. Lock form and seal or continuously weld joints.
 - 3. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
 - 4. Reinforcement: Cross or trapeze angles for rigid suspension.
- I. Source Quality Control:
 - 1. Acoustic Performance: Test according to ASTM E 477-13 in facility certified to ISO/IEC 17025:2005 by The National Voluntary Laboratory Accreditation Program (NVLAP), utilizing the most current version of NVLAP guidelines.
 - 2. Record acoustic ratings, including dynamic insertion loss and self-noise power levels with an airflow of at least 2000-fpm face velocity.
 - 3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.
- J. Silencer Types:
 - 1. Duct Mounted, Rectangular Absorptive: Type RA
 - 2. Duct Mounted, Rectangular, no media (packless): Type RP.
 - 3. Air Handling Unit Mounted Absorptive: Match product requirements noted for Type RA. Refer to Section 23 7412 "Custom Air-Handling Units" for performance requirements.

2.7 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
- B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.
 - 1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Duro Dyne Corp.
 - c. Ward Industries, Inc.

2.8 DUCT-MOUNTING ACCESS DOORS

- A. General Description: Fabricate doors airtight and suitable for duct pressure class.
- B. Standard bolted access door: Oval outer door connected to an inner plate by spring loaded carriage bolts, with hand knobs for tightening, inert cellular sponge gasket, and permanently bonded polyester insulation (to prevent moisture from forming on outer surface).
 - 1. Manufacturers:
 - a. American Warming and Ventilating
 - b. Ductmate Industries, Inc.
 - c. Flexmaster U.S.A., Inc.
 - d. Greenheck.

- e. McGill Airflow Corporation.
 - f. Nailor Industries, Inc.
 - g. Portoff
 - h. Ventfabrics, Inc.
 - i. Ward Industries, Inc.
 2. Doors shall be leak free at 20" w.g. static pressure.
 3. Doors shall be equal to McGill Airflow Corporation Model AOBXFSDF for rectangular ducts and Model AOBXFSDC for round ducts.
- C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.
1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Flexmaster U.S.A., Inc.
 2. Frame: Galvanized sheet steel, with spin-in notched frame.
- D. For round ducts too small to locate other specified access doors, provide hinged access doors.
1. Manufacturers:
 - a. Semco.
 - b. Approved equal.
 2. Door shall be 20 gauge galvanized steel.
 3. Hinge shall be continuous type.
 4. Latches shall be sash lock type and a minimum of 3 (one on each side, except hinge side) shall be provided.
 5. Gasket provided shall be continuous.
 6. Doors shall be suitable for the pressure class of the duct systems in which they are located.
 7. Externally insulate access doors in insulated duct systems. Insulation shall be equal to type and thickness specified for the duct system in Section 23 0700 "Mechanical Insulation."
 8. Hinged access doors shall be equal to Semco type S40.

2.9 ROUND TAKEOFF FITTINGS

- A. Manufacturers:
1. Flexmaster U.S.A., Inc.
 2. Approved equal.
- B. Provide integral locking hand quadrant type volume damper where indicated or where round takeoff fittings are located at round duct branches serving air devices. Volume damper shall be complete with standoff for 2" insulation, square shaft, U-bolt, nylon bushings, locking quadrant, and damper blade.
- C. Seal fittings as follows:
1. Spot or tack welded and sealed with a specified sealant for pressure classes from minus 2-inch wg to plus 2-inch wg, unless otherwise indicated.
 2. Continuously welded for pressure classes from plus 2-inch wg to 10-inch wg, unless otherwise indicated.
- D. Conical fittings:
1. Spin-in type.

2. Constructed of a two-piece 26-gauge G-90 galvanized steel body and factory sealed for high pressure applications.
3. Overall length of the fitting shall be 6" without damper and 10" with damper.
4. Round outlet shall be provided with a rolled stiffener bead for strength and ease of installation and sealing of spiral and flexible ductwork joints.
5. Conical fittings shall be equal to Flexmaster Model CB.

E. Flared fittings:

1. Spin-in type.
2. Constructed of 26 gauge G-90 galvanized steel.
3. Overall length of the fitting shall be 3" without damper and 7" with damper.
4. Round outlet shall be provided with a rolled stiffener bead for strength and ease of installation and sealing of spiral and flexible ductwork joints.
5. Flared fittings shall be equal to Flexmaster Model FL.

F. Side takeoff fittings:

1. Maintain a ratio of 1:1 of inlet to outlet on units over 7" diameter to allow proper sizing of the duct system.
2. Incorporate a 45-degree rectangular entry to minimize pressure drop.
3. Include a 1" wide pre-punched mounting flange with corner clips and adhesive gasket for minimal leakage and ease of installation.
4. Constructed of a two-piece 26-gauge G-90 galvanized steel body and collar.
5. Overall length of the fitting shall be 13" with or without damper to reduce turbulence in the airstream.
6. Round outlet shall be provided with a rolled stiffener bead for strength and ease of installation and sealing of spiral and flexible ductwork joints.
7. Side takeoff fittings shall be equal to Flexmaster Model STO.

2.10 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Ductmate Industries, Inc.
2. Duro Dyne Corp.
3. Ventfabrics, Inc.
4. Ward Industries, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Extra-Wide Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA HVAC Duct Standard.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 20 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..

2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 10 to plus 250 deg F.

2.11 FLEXIBLE DUCTS

- A. Manufacturers:
 1. Atco Rubber Products, Inc.
 2. Flexmaster U.S.A., Inc.
 3. Hart & Cooley, Inc.
 4. McGill AirFlow Corporation.
- B. Insulated-Duct Connectors: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor barrier film.
 1. Pressure Rating: 10-inch wg positive and 0.5-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 10 to plus 140 deg F, continuous.
- C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.
- D. Flexible Duct Elbows: Provide rigid elbow product for flexible ducts, equivalent to Hart & Cooley Smart Flow Elbow.

2.12 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation and sound lining thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards—Metal and Flexible—Second Edition," NAIMA AH124 "Fibrous Glass Duct Liner Standard," and in NAIMA AH116, "Fibrous Glass Duct Construction Standards".
- B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install motorized dampers and backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.
- E. Provide volume dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from

branch takeoff. Variations in damper locations (from those indicated in the contract documents) must be approved in writing by the Architect.

- F. Provide manual remote control volume dampers where volume dampers are located above inaccessible ceilings (gypsum, plaster, etc.).
- G. Manual remote control volume damper cable installation shall be per manufacturers installation instructions, minimum turn radius of 4", provide retainers to support bends. Secure cable to building structure to avoid accidental adjustment from other trades.
- H. Provide test holes at fan inlets and outlets where indicated and where required for testing and balancing.
- I. Install fire and smoke dampers with fusible links and electric sensors or thermostats, according to manufacturer's UL-approved written instructions.
- J. Install duct silencers rigidly to ducts.
- K. Install duct round or oval access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
 - 1. On both sides of duct coils.
 - 2. On both sides of duct air-flow measuring stations.
 - 3. Adjacent to duct static-pressure measuring probes, providing access for inspection and cleaning.
 - 4. Downstream from volume dampers and equipment.
 - 5. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
 - 6. Adjacent to duct smoke detectors, providing access for inspection and cleaning.
 - 7. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
 - 8. On sides of ducts where adequate clearance is available.
 - 9. On both sides of duct silencers.
- L. Install the following sizes for duct-mounting, oval access doors:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
 - 5. Body Access: 25 by 14 inches.
 - 6. Body Plus Ladder Access: 25 by 17 inches.
- M. Install the following sizes for duct-mounting, round access doors:
 - 1. One-Hand or Inspection Access: 8 inches in diameter.
 - 2. Two-Hand Access: 10 inches in diameter.
 - 3. Head and Hand Access: 12 inches in diameter.
 - 4. Head and Shoulders Access: 18 inches in diameter.
 - 5. Body Access: 24 inches in diameter.
- N. Label access doors according to Section 23 0553 "Identification for Mechanical."
- O. Provide round takeoff fitting where round ductwork takes off from rectangular ductwork in accordance with the following:

1. Provide conical-type fittings where round takeoff is 3" or less than the rectangular duct size.
 2. Provide flared-type fittings where round takeoff size is between 2" and 3" less than the rectangular duct size.
 3. Provide side takeoff fittings where rectangular duct size is not at least 2" greater than round takeoff size.
- P. Install metal nosing at duct access doors and duct taps installed in ducts with liner. Seal liner behind nosing with adhesive.
- Q. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- R. For fans developing static pressures of 5-inch wg and higher and for air handling units, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- S. Connect terminal units to supply ducts directly. Do not use flexible ducts.
- T. Connect diffusers to low pressure ducts directly or with maximum 60-inch lengths of flexible duct as shown in manufacturer's installation instructions and with 3 wraps of approved tape and stainless steel draw band for tight seal.
1. Provide rigid flexible duct elbows.
 2. Refer to Section 23 3713 "Diffusers, Registers, and Grilles" for connection requirements above inaccessible (gypsum, etc.) ceilings.
- U. Connect flexible ducts to metal ducts as shown in manufacturer's installation instructions and with 3 wraps of approved tape and stainless steel draw band for tight seal. For installations above gypsum ceilings, first apply duct sealer to collar before wrapping with tape. Seal insulation with 3 wraps of tape as shown in manufacturer's installation instructions.
- V. Install duct test holes where indicated and required for testing and balancing purposes.
- 3.2 ADJUSTING
- A. Adjust duct accessories for proper settings.
 - B. Adjust fire and smoke dampers for proper action.
 - C. Final positioning of manual-volume dampers is specified in Section 23 0593 "Testing, Adjusting, and Balancing for HVAC."
- 3.3 COMMISSIONING
- A. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 1. Section 01 9113 "General Commissioning Requirements."

END OF SECTION

SECTION 23 3423

HVAC POWER VENTILATORS

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. This Section includes the following:
 - 1. In-line Centrifugal Fans.
- B. Related sections include the following:
 - 1. Section 23 0513 "Common Motor Requirements for Mechanical Equipment" for related motor requirements.
 - 2. Section 23 7413 "Modular Air Handling Units" for integral fans.
 - 3. Section 23 8126 "Split System Units" for integral fans.
 - 4. Section 23 8219 "Fan Coil Units" for integral fans.
 - 5. Section 23 8239 "Unit Heaters" for integral fans.
 - 6. Most of the HVAC systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - a. Section 01 9113 "General Commissioning Requirements."

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base air ratings on sea-level conditions.
- B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material gages and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 - 2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

- C. Maintenance Data: For power ventilators to include in maintenance manuals specified in Division 01.
- D. In addition, High Plume Dilution Exhaust System submittals shall:
 - 1. Provide dimensional drawings and product data on each high-plume dilution laboratory exhaust fan assembly.
 - 2. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted.
 - 3. Provide nozzle velocity of exhaust fan, total exhaust flow, and discharge plume rise at specified wind velocity.
 - 4. Strictly adhere to QUALITY ASSURANCE requirements.

1.5 QUALITY ASSURANCE

- A. 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.
- B. AMCA Compliance: Conform to AMCA standard 210 and 300. Fans must be tested in accordance with AMCA 210 and 300 in an AMCA accredited laboratory. Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 03 3300 "Cast-in-Place Concrete."
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. In-Line Centrifugal Fans:
 - a. Acme Engineering & Mfg. Corp.
 - b. Cook, Loren Company.
 - c. Greenheck Fan Corp.
 - d. PennBarry.
 - e. Twin City.

2.2 IN-LINE CENTRIFUGAL FANS (IL)

- A. Description: In-line, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, mounting brackets, and accessories.
- B. Housing: Square or round design constructed of heavy gauge galvanized steel with square duct mounting collars, minimum two removable access panels located perpendicular to motor mounting panel, and support bracket adaptable to floor, side wall, or ceiling mounting.
1. Access panels shall be of sufficient size to permit easy access to interior components.
 2. Inlet and Outlet Configuration: In-line or perpendicular to inlet, as indicated otherwise on drawings.
- C. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- D. Fan Wheels: Centrifugal, backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.
- E. Fan Shafts and Bearings: Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated heavy-duty, self aligning pillow block ball bearings with AMCA 9, L₁₀ of 80,000 hours at maximum cataloged operating speed.
- F. Motors and drives shall be mounted out of the airstream. Motors shall be readily accessible for maintenance. For motors used with variable frequency controllers, provide shaft grounding brush equal to Aegis SGR™ Conductive Microfiber™: refer to Section 23 0513 "Common Motor Requirements for Mechanical Equipment".
- G. Accessories:
1. Companion Flanges: For inlet and outlet duct connections.
 2. Motor and Drive Cover (Belt Guard): Galvanized or painted steel.
 3. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
- H. SOUND LEVELS

1. The sound power levels shall not exceed the scheduled values indicated herein when operating throughout its operating range, and maximum design airflow and static pressure conditions scheduled.

Maximum Sound Power Levels (dB)	Octave Band Center Frequency (HZ)							
	63	125	250	500	1K	2K	4K	8K
Inlet	86	86	87	77	73	72	70	64
Radiated	89	87	83	71	65	57	52	48

2.3

2.3

2.3 MOTORS

- A. Comply with requirements in Section 23 0513 "Common Motor Requirements for Mechanical Equipment."

2.4 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support units using vibration isolators. Vibration control devices are specified in Section 23 0548 "Mechanical Vibration Control."
- C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Section 03 3300 "Cast-in-Place Concrete."
- D. Secure roof-mounting fans to vibration isolators on roof curbs with cadmium-plated hardware. Vibration control devices are specified in Section 23 0548 "Mechanical Vibration Control."
- E. Support suspended units from structure using threaded steel rods and vibration isolators. Vibration-control devices are specified in Section 23 0548 "Mechanical Vibration Control."
- F. Install units with clearances for service and maintenance.
- G. Label units according to requirements specified in Section 23 0553 "Identification for Mechanical."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 23 3300 "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment.
- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Equipment Startup Checks:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Verify lubrication for bearings and other moving parts.
 - 6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 7. Disable automatic temperature-control operators.
- B. Starting Procedures:
 - 1. Energize motor and adjust fan to indicated rpm.
 - 2. Measure and record motor voltage and amperage.
- C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
- D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Shut unit down and reconnect automatic temperature-control operators.
- F. Refer to Section 23 0593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- G. Replace fan and motor pulleys as required to achieve design airflow.
- H. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

- I. Most of the HVAC systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 1. Section 01 9113 "General Commissioning Requirements".

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.

3.5 CLEANING

- A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.
- B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

- A. Refer to Section 01 7350 "Demonstration and Training" for training requirements for Owner's maintenance personnel and building occupants.

END OF SECTION

SECTION 23 3713

DIFFUSERS, REGISTERS, AND GRILLES

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. This Section includes ceiling-, floor-, duct-, and wall-mounted diffusers, registers, and grilles.
- B. Related Sections include the following:
 - 1. Section 08 9100 "Louvers" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
 - 2. Section 23 3300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
- C. Refer to drawings for air devices that will require custom curving to match adjacent walls, ceilings, and floors. Refer to Architectural drawings for radius of curve.

1.3 SUBMITTALS

- A. Product Data: For each product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and NC-value noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, accessories furnished, NC-value, pressure drop, and finish.
- B. Color Samples: For diffusers, registers, and grilles, Architect to select color.

1.4 SELECTION CRITERIA

- A. Air devices shall be selected for 5 DB lower than the listed Noise Criteria of the Room.
- B. Noise Criteria of Room:
 - 1. Rooms with NC 25 Criteria: Classrooms and Videoconference Rooms.
 - 2. Rooms with NC 30 Criteria: Conference/Seminar Rooms and Private Offices.
 - 3. Rooms with NC 35 Criteria: Chemistry Labs, Student Breakout Areas, Common Areas, and all spaces not mentioned in the other NC categories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles below where titles introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products equal to Basis of Design indicated, by one of the manufacturers specified.

2.2 GRILLES AND REGISTERS

- A. Fixed Bar Grille (Type RG):
1. Basis of Design: Titus Model 350RL.
 2. Manufacturers:
 - a. Carnes.
 - b. Krueger.
 - c. Nailor Industries of Texas Inc.
 - d. Titus.
 - e. Tuttle & Bailey.
 - f. Price Industries.
 3. Material: Steel.
 4. Finish: Color selected by Architect.
 5. Face Blade Arrangement: Fixed horizontal spaced 3/4 inch apart; 35 degree deflection.
 6. Frame: 1-1/4 inches wide.
 7. Mounting: Countersunk screw.
- B. Adjustable Bar Grille (Type SGA):
1. Basis of Design: Titus Model 272RL.
 2. Manufacturers:
 - a. Carnes.
 - b. Krueger.
 - c. Nailor Industries of Texas Inc.
 - d. Titus.
 - e. Tuttle & Bailey.
 - f. Price Industries.
 3. Material: Steel.
 4. Finish: Color selected by Architect.
 5. Face Blade Arrangement: Adjustable horizontal spaced 3/4 inch apart.
 6. Rear Blade Arrangement: Adjustable vertical spaced 3/4 inch apart.
 7. Frame: 1-1/4 inches wide.
 8. Mounting: Countersunk screw.
- C. Fixed Bar Grille (Type RGA):
1. Basis of Design: Titus Model 350RL.
 2. Manufacturers:
 - a. Carnes.
 - b. Krueger.
 - c. Nailor Industries of Texas Inc.
 - d. Titus.
 - e. Tuttle & Bailey.
 - f. Price Industries.
 3. Material: Steel.

4. Finish: Color selected by Architect.
5. Face Blade Arrangement: Fixed horizontal spaced 1/2 inch apart; 45 degree deflection.
6. Frame: 1-1/4 inches wide.
7. Mounting: Countersunk screw.

2.3 LINEAR SLOT OUTLETS

A. Linear Bar Diffuser (Type LBG):

1. Basis of Design: Titus Model CT.
2. Manufacturers:
 - a. Carnes.
 - b. Krueger.
 - c. Nailor Industries of Texas Inc.
 - d. Titus.
 - e. Tuttle & Bailey.
 - f. Price Industries.
3. Material: Extruded Aluminum.
4. Finish: Color selected by Architect.
5. Spacing Arrangement: 7/32-inch-thick blades spaced 7/16 inch apart, 0-degree deflection, fixed bars.
6. Frame: 1 inch wide.
7. Mounting: Concealed bracket.
8. Accessories: End borders, Alignment pins, and Blank-off strips.

B. Linear Slot Diffuser (Type LS):

1. Basis of Design: Titus ML-38
2. Manufacturers:
 - a. Carnes.
 - b. Krueger.
 - c. Nailor Industries of Texas Inc.
 - d. Price
 - e. Titus.
 - f. Tuttle & Bailey.
3. Material: Extruded Aluminum.
4. Finish – Face: Baked enamel, color selected by Architect.
5. Finish - Pattern Controller: Baked enamel, black.
6. Frame: 1-1/4 inch flange.
7. Mounting: Concealed bracket.
8. Pattern Controller: Aerodynamically curved, two-element, steel deflector, capable of 180 degree pattern adjustment from face of diffuser.
9. Slot Width: Refer to drawings.
10. Number of Slots: Refer to drawings.
11. Accessories: Alignment pins and Blank-off strips.

C. Linear Slot Diffuser (Type LR):

1. Basis of Design: Titus MLR-38.
2. Manufacturers:

- a. Carnes.
 - b. Krueger.
 - c. Nailor Industries of Texas Inc.
 - d. Price
 - e. Titus.
 - f. Tuttle & Bailey.
3. Material: Extruded Aluminum.
 4. Finish: Baked enamel, color selected by Architect.
 5. Frame: 1-1/4 inch flange.
 6. Mounting: Concealed bracket.
 7. Pattern Controller: None.
 8. Slot Width: Refer to drawings.
 9. Number of Slots: Refer to drawings.
- D. Accessories: End borders, Alignment pins and Blank-off strips.
- 2.4 CEILING DIFFUSER OUTLETS
- A. Square Panel Ceiling Diffusers (Type CD and CR):
1. Basis of Design: Titus Model Omni.
 2. Manufacturers:
 - a. Carnes.
 - b. Krueger.
 - c. Nailor Industries of Texas Inc.
 - d. Titus.
 - e. Tuttle & Bailey.
 - f. Price Industries.
 3. Material: 0.034 inch thick Steel.
 4. Finish: Color selected by Architect.
 5. Face Size: 24 by 24 inches (unless indicated otherwise).
 6. Face Style: Architectural panel, single piece, removable.
 7. Mounting: T-bar.
 8. Pattern: Fixed.
 9. Accessories: Directional blow clips.
- B. Perforated Diffuser (Type PCD and PCR):
1. Basis of Design: Titus Model PAS and PAR.
 2. Manufacturers:
 - a. Carnes.
 - b. Krueger.
 - c. Nailor Industries of Texas Inc.
 - d. Titus.
 - e. Tuttle & Bailey.
 - f. Price Industries.
 3. Material: .034 inch thick Steel.
 4. Finish: Color selected by Architect.
 5. Face Size: 24 by 24 inches (unless indicated otherwise).
 6. Face Style: Flush, single piece, removable.
 7. Mounting: T-bar.
 8. Pattern: Adjustable for PCD, none for PCR.

2.5 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb, and in accordance with Manufacturer's written instructions.
- B. Ceiling- and Wall-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable.
 - 1. Refer to the Architectural floor plans, sections, and reflected ceiling plans for exact location of air devices. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
 - 2. Ceiling diffuser outlets installed in gypsum ceilings shall not be installed with plaster frames. At the Contractor's option for supply ductwork, flexible duct may be used to connect diffuser to main duct. Diffuser and an adequate amount of hard duct must be supported from the building structure prior to connection with flexible duct for installation of diffuser. Coordinate the installation of the air devices with the sequencing of the gypsum ceiling installation.
 - 3. Support diffusers, registers, grilles, and plenums independently of ceiling construction.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- D. Construct and install duct and plenum connections to diffusers, registers, and grilles in accordance with manufacturer's written instructions.
- E. Modify duct systems (transitions, collars, etc.) as required to accommodate actual sizes of grilles, registers, and diffusers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 23 4100

PARTICULATE AIR FILTRATION

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. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.
- B. Related Sections:
 - 1. Section 01 8113 "Sustainable Design Requirements" for additional filter requirements.

1.3 DEFINITIONS

- A. MERV: Minimum Efficiency Reporting Value.

1.4 SUBMITTALS

- A. Product Data: Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.
- B. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.
 - 1. Filter List: Include sizes and quantities for each piece of equipment, including pre-purchased equipment.
- C. LEED Submittals:
 - 1. Credit EQ 3.1: Manufacturers' product data for temporary filtration media and filtration media used during construction.
 - 2. Credit EQ 3.2: Manufacturers' product data for filtration media used during flush-out and filtration media used prior to occupancy.
 - 3. Credit EQ 5: Manufacturers' product data for permanent filtration media.

1.5 QUALITY ASSURANCE

- A. 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.
- B. Comply with ARI 850.
- C. Comply with ASHRAE 52.2 for method of testing and rating air-filter units.

D. Comply with NFPA 90A and NFPA 90B.

E. Comply with UL 900.

1.6 EXTRA MATERIALS

A. Provide filter media as required for operation of the air-handling systems throughout construction, and building air flush-out.

B. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Provide minimum two complete sets of filters for each filter bank.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Filters:
a. AAF International.
b. Cambridge / Farr Co.
c. Flanders Filters, Inc.
2. Filter Gages:
a. Airguard Industries, Inc.
b. Dwyer Instruments, Inc.

2.2 PLEATED-TYPE, DISPOSABLE PANEL PRE-FILTERS (TYPE PF)

A. Description: Factory-fabricated, dry, extended-surface filters; UL listed as Class 2.

B. Media: Fibrous non-woven cotton and synthetic fabric material formed into deep-V-shaped pleats and held by self-supporting welded wire grid.
1. Pleats per linear foot:
a. 1-inch and 2-inch thick: Minimum 15
b. 4-inch thick: Minimum 11
2. Square-foot of media per square foot of filter face area:
a. 1-inch thick: Minimum 2.4 sq. ft.
b. 2-inch thick: Minimum 4.3 sq. ft.
c. 4-inch thick: Minimum 6.9 sq. ft.

C. Media and Media-Grid Frame: Nonflammable cardboard, with diagonal support members.

2.3 RIGID, DEEP-PLEATED SUPPORTED MEDIA FINAL FILTERS (TYPE FF)

A. Description: Factory-fabricated, dry, rigid, V-bank mini-pleated fiberglass, self-supporting disposable filters; UL listed as Class 2.

B. Media: High-density microfine glass fibers in V-bank configuration, laminated to reinforcing backing, forming a uniform lofted media blanket. Media shall be mechanically and chemically bonded within the frame.

1. Square-foot of media per square-foot of filter face area:
 - a. 4-inch thick: Minimum 26.5 sq. ft.
 - C. Filter-Media Frame: Rigid plastic.
- 2.4 RIGID, DEEP-PLEATED SUPPORTED CARBON MEDIA FILTERS (TYPE CF)
- A. Basis of Design: Camfil Farr Model Camsorb Rigacarb Type 201.
 - B. Description: Factory-fabricated, adsorbent-type, high-lofted supported media, V-bank style, assembled in a compact and secure enclosing frame.
 - C. Media: Activated carbon adsorbent media specifically designed to remove ozone, gaseous contaminants associated with photocopiers, cleaning products, paint odors, furniture off-gassing, and human bio effluents.
 1. The filter media shall incorporate a rapid adsorption dynamic (RAD) for increased adsorption performance and contaminant adsorption rate.
 2. The media blanket shall be formed into uniform tapered radial pleats and bonded to a stiffened backing that is bonded to the downstream side of the media to preclude media oscillation. There shall be no less than 10 pleats per linear foot of filter face area.
 3. Media shall be mechanically and chemically bonded within the frame to prevent air bypass.
 - D. Filter-Media Frame: The enclosing frame shall be constructed of corrosion resistant galvanized steel. Media support contour stabilizers, shall be mechanically fastened to the diagonal support members to create a rigid and durable filter enclosure. There shall be a minimum of four contour stabilizers on the air entering side and four on the air exiting side.
 - E. Performance: The filter shall have a minimum initial toluene removal efficiency of >95% (at 500 fpm; 73° F, 50% RH, 80 ppm toluene). The filter shall have a minimum initial ozone removal efficiency of 90% (at 500 fpm, 73° F, 50% RH, 500 ppb ozone).
- 2.5 TEMPORARY FILTERS (Type TF)
- A. Description: Factory-fabricated, dry, high-capacity extended-surface filters; UL listed as Class 2.
 - B. Media: Fibrous 100 percent synthetic continuous fiber material with gradient layers formed into deep-V-shaped pleats and held by self-supporting welded wire grid.
 1. Particle Capture Principal: Electrostatic and mechanical.
 2. Efficiency: MERV 8.
 3. Thickness: 2 inches.
 4. Pleats per linear foot: Minimum 15
 5. Square-foot of media per square foot of filter face area: Minimum 4.3 sq. ft.
 6. Maximum Pressure Drop: 0.07 inches w.g. at 250 feet per minute face velocity.
 - C. Media and Media-Grid Frame: Nonflammable cardboard, with diagonal support members.
- 2.6 FILTER GAGES
- A. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, adjustable signal flag, and front recalibration adjustment.

1. Diameter: 4 inches.
2. Range: 0- to 2.0-inch wg.

B. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install filters in equipment frames to prevent passage of unfiltered air.
- B. Install filter gage for each filter bank.
- C. Install filter gage static-pressure tips upstream and downstream from filters to measure pressure drop through filter. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Coordinate filter installations with duct and air-handling unit installations.

3.2 FILTER REQUIREMENTS DURING CONSTRUCTION

- A. Refer to Section 01 5000 "Temporary Facilities and Controls" and Section 01 8113 "Sustainable Design Requirements" for requirements.
- B. Prior to initial energizing of air-handling units, install the following:
 1. Pre and final filters (types PF and FF) in air-handling units.
 2. Temporary filters (type TF) on return air inlets. Provide temporary supports and transitions, plenums, etc. as required to attach filters to return air inlets, and limit face velocity to 500 feet per minute.
- C. Replace all air filters immediately prior to building air flush-out. Install prefilters (type PF) and final filters (type FF) in air handling units. Replace air filters after building air flush-out.
- D. Replace filters as they approach the manufacturer's recommended maximum pressure drops, or as required for proper airflow (whichever is more frequent) throughout the construction period. Refer to EXTRA MATERIALS Article.

3.3 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION

SECTION 23 5700

HEAT EXCHANGERS FOR HVAC

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. This Section includes plate heat exchangers.
- B. Related Sections include the following:
 - 1. Most of the mechanical systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - a. Section 01 9113 "General Commissioning Requirements."

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories. Submit certificate of performance to verify ARI-400 compliance.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
- C. Coordination Drawings: Equipment room, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members to which heat exchangers will be attached.
- D. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.
 - 1. Include completed start-up service documentation and manufacturer's warranty within operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, performance, and dimensional requirements of heat exchangers and are based on the specific equipment indicated. Refer to Section 01 6000 "Product Requirements."
- B. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.
- C. Units shall be registered with National Board of Boiler and Pressure Vessel Inspectors.

D. ARI-400 Compliance.

1.5 WARRANTY

A. Manufacturer shall provide warranty for two years from date of acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 GASKETED PLATE HEAT EXCHANGERS

- A. Manufacturers:
1. Alfa Laval Thermal, Inc.
 2. Bell & Gossett; Div. of ITT Industries.
 3. Tranter.
- B. Configuration: Countercurrent type flow arrangement with freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets.
- C. Frame: Painted carbon steel with provisions for anchoring to support.
- D. Top and Bottom Carrying and Guide Bars: Type 304 stainless steel.
1. Fabricate attachment of heat-exchanger carrying and guide bars with reinforcement strong enough to resist heat-exchanger movement during a seismic event when heat-exchanger carrying and guide bars are anchored to building structure.
- E. End-Plate Material: Painted carbon steel.
- F. Tie Rods and Nuts: Zinc plated carbon steel or stainless steel.
- G. Plate Material: Minimum 0.015 inch (40 mm) thick before stamping; Type 304 stainless steel.
- H. Gasket Material: Peroxide-cured, nitrile-rubber.
- I. Piping Connections: Flanged inlet and outlet fluid connections, threaded drain, and vent connections.
- J. Enclose plates in a solid aluminum or stainless-steel removable shroud. Removable shroud shall be insulated panel covers interlocked for rigidity and thermal barrier.
- K. Capacity and Characteristics: As scheduled and indicated on drawings.
- L. Source Quality Control: Certify in accordance with ARI 400. Factory tested at 150 psig and 150 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HEAT-EXCHANGER INSTALLATION

- A. Install heat exchangers according to manufacturer's written instructions.
- B. Install heat exchangers plumb and level; anchor with supports.
- C. Concrete Bases: Secure heat exchanger to vibration isolator pad mounted on concrete base.
 - 1. Vibration isolation pads are specified in Section 23 0548 "Mechanical Vibration Control."
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use 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. Cast-in-place concrete materials and placement requirements are specified in Division 03.
- D. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections maintaining clearances for service and maintenance of heat exchangers and tanks.
- E. Install shutoff valves at heat exchanger inlet and outlet connections.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections to allow service and maintenance of heat exchangers.
- C. Install piping appurtenances and shutoff valves at heat-exchanger inlet and outlet connections.
- D. Install hose end valve to drain heat exchanger.

3.4 FIELD QUALITY CONTROL

- A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

- C. Engage a factory-authorized service representative to witness startup.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
- D. Include completed start-up service documentation within operation and maintenance manuals.

3.5 CLEANING

- A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers. Refer to Section 01 7350 "Demonstration and Training."

END OF SECTION

SECTION 23 7413
MODULAR AIR-HANDLING UNITS

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 modular indoor air-handling units.
- B. Related Sections include the following:
 - 1. Temperature controls except for devices herein specified to be factory installed are specified in Section 23 0900 "Instrumentation and Control for HVAC."

1.3 SUBMITTALS

- A. Product Data: For each type of modular air-handling unit indicated. Include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound power ratings at design duty.
 - 3. Certified coil-performance ratings with system operating conditions indicated.
 - 4. Heat wheel performance data.
 - 5. Motor ratings, electrical characteristics, and motor and fan accessories.
 - 6. Material gages and finishes.
 - 7. Filters with performance characteristics.
 - 8. Dampers, including housings and linkages, with performance characteristics.
 - 9. Smoke and fire rating data of materials used in contact with air stream.
- B. Shop Drawings:
 - 1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 - 2. Drawings depicting arrangement and dimensions of each component.
- C. Field Quality-Control Test Reports: From manufacturer.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain modular air-handling units through one source from a single manufacturer with resources to provide products complying with requirements indicated without delaying the Work.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of modular outdoor air-handling units. Refer to Section 01 6000 "Product Requirements."

- 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. ARI Certification: Modular air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI. Coils shall be certified in accordance with ARI Standard 410.
- E. Comply with NFPA 70.
- F. Sound Power Level Ratings: Test units in accordance with ARI Standard 260 "Sound Rating of Ducted Air Moving and Air Conditioning Equipment."

1.5 COORDINATION

- A. Coordinate exact size and location with structure steel for unit mounting.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: two sets for each modular air-handling unit.
 - 2. Gaskets: one set for each access door.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Units shall be stored and handled in accordance with the unit manufacturer's instructions.
- B. Inspect for transportation damage and store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish. Replace damaged coils, components, etc., when directed, at no charge to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier; Div. of United Technologies Corp.
 - 2. Daikin Applied.
 - 3. Trane Company (The); Worldwide Applied Systems Group.
 - 4. York International Corporation.

2.2 MANUFACTURED UNITS

- A. Modular air-handling units shall be factory assembled and consist of fans, motor and drive assemblies, humidifiers (where indicated), coils, heat wheels (where indicated), plenums, filters, condensate pans, control devices, and accessories.

- B. Provide units with capacity and components as specified and scheduled. Footprint of assembled units shall not exceed sizes indicated on contract drawings without written approval of Architect. Unit configurations, locations of coil connections, and access sections shall all be as indicated on the contract drawings.
- C. Refer to drawings for required components in each unit.

2.3 CABINET

- A. Materials: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Construction:
 - 1. Casings shall be capable of withstanding up to 6-inch wg positive or 4-inch wg negative pressures.
 - 2. Unit sections shall be supplied with G90 galvanized steel structural support base rails designed to support the unit. Provide intermediate base members as required to support components and personnel.
 - 3. Perimeter lifting lugs for overhead rigging shall be provided on each section.
 - 4. Modular unit panels (top, sides, and bottom) shall be minimum 2-inch thick double wall, weather tight and constructed of minimum 16-gage outer and 20-gage inner G90 galvanized steel, except cooling coil section, which shall have 20 gauge, 304 stainless steel interior panel. Interior floor panels shall be minimum 16 gauge.
 - 5. Casing panels and frames shall have thermal break construction.
 - 6. Side panels shall be easily removable for access to unit and sealed against a full perimeter gasket.
 - 7. Casing panels shall be removable for easy access to unit. Panels shall be gasketed to ensure an air-tight seal.
 - 8. Each component section shall have mating flanges for field assembly. The flange shall extend around the complete perimeter of each section. Fasteners shall be located no further than 12 in. on center. The manufacturer shall install closed cell gasket for full perimeter coverage.
 - 9. Fan supports, structural members, panels, or flooring shall not be welded, unless aluminum, stainless steel, or other corrosion-resistant material is used.
 - 10. The fan sections shall have a G90 galvanized steel floor of sufficient strength to enable field personnel to service or adjust the motor and drive without damaging the insulation. A double-wall hinged access door shall be provided on accessible side(s) of the fan sections and allow full access to fan motor, drive and bearings.
 - 11. Coil section shall have coil tracks and removable end panels to facilitate coil or humidifier manifold removal.
 - 12. Filter sections shall be designed and constructed with gasketed filter rails to house the specific type of filter shown on the equipment schedule. A double-wall hinged access door shall be provided on accessible side(s) of filter section. Filters shall be removable from one side (same side as coil access).
 - 13. Access sections shall have a double-wall hinged access door on accessible side(s) of each section. Access sections shall be minimum 24 inches wide in direction of airflow, except access sections upstream of fan section shall be 36 inches wide.
- C. Insulation: Each section shall be factory insulated. Insulation shall have full coverage waterproof adhesive to firmly secure the material to the unit casing interior and exterior panels. Insulation

and insulation adhesive shall comply with NFPA 90A requirements for flame spread and smoke generation.

1. 2-in., 3 lb per cu. ft density, 12 R-value, polyurethane foam for indoor units.

D. Access Doors: Shall be of double wall construction. Hinge pins shall be non-removable to avoid loss. Sufficient handles shall be provided to assure positive closure. Doors shall be gasketed and shall open outward for negative pressure sections and inward for positive pressure sections.

All fan and access sections shall have handles on inside and outside of door in compliance with OSHA requirements for confined space access. Fan section shall have double-glazed view ports capable of withstanding unit operating pressures. Access doors shall be provided on accessible side(s) of the specified sections as indicated on the drawings. All access doors shall have test ports.

1. If fan section doors open with pressure, provide safety chain and latch that allows door to partially open. When pressure is relieved and latch is disengaged, door may fully open.

E. Drain Pans: Drain pans shall be constructed of insulated double wall stainless steel. The pan shall be sloped toward the drain fitting. Drain pan shall have a recessed bottom drain design with integral FPT elbow for side discharge and trapping on accessible side of unit. One drain outlet shall be supplied for each section containing a drain pan. Drain pan shall allow no standing water and comply with ASHRAE Standard 62. Where 2 or more coils are installed in a coil bank, intermediate drain pans shall be provided that extend a minimum of 6 in. from the downstream side of the upper coil face and the condensate shall be piped to the bottom drain pan. The bottom coil shall not serve as a drain path for the upper coil. Provide drain pans in the following sections:

1. Cooling coils.

F. Casing Strength: For Draw-Thru sections casing shall be designed for a maximum 1:200 deflection ratio up to 3.5 in. static pressure, and with no permanent deformation at maximum shutoff pressure of fan.

G. Housing shall be constructed such that air leakage rate does not exceed ½% of the design airflow when operating at 10" positive static pressure and 5" negative static pressure.

H. Service Lights: Units shall be furnished from the manufacturer with marine service lights in each fan compartment and access section. All lights in the air stream shall be LED, vapor proof fixtures and wire guard. Lights shall be factory wired and controlled from a 1-hour light timer switch on the exterior of the unit, suitable for a single 120-volt field connection.

I. Provide safing, galvanized steel or stainless steel as applicable, to prevent bypass around filters, coils, etc.

2.4 FANS

A. General:

1. Refer to fan schedule on drawings for type of fans to be provided for each unit. Refer to drawings for fan arrangements.
2. Fan sections shall have direct-drive plenum fans. Airfoil blades shall be double thickness design. They shall be painted with zinc chromate primer and enamel paint. Fans shall have a minimum AMCA Class II rating.

3. Fan wheels shall be keyed to the shaft and shall be designed for continuous operation at maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected with a maximum operating speed 25% below the first critical, and shall be statically and dynamically balanced as an assembly.
4. Fan shafts shall be solid steel, turned, ground, polished and coated with rust preventative oil.

- B. Mounting: Fan scroll, wheel, shaft, drives, and motor shall be mounted on a common base assembly which shall be isolated from the unit base with spring vibration isolators as specified in Section 23 0548 "Mechanical Vibration Control". Fan outlets shall be isolated from casing with flexible connections.

2.5 MOTORS

- A. General: Install on slide base to permit fit up to fan.
- B. Characteristics: Indicated in Section 23 0513 "Common Motor requirements for Mechanical Equipment", compatible with Section 23 2923 "Variable-Frequency Motor Controllers".
- C. Motor Sizes: Minimum size as indicated and large enough so driven load will not require motor to operate in service factor range.
- D. Enclosure Type: The following features are required:
1. Open dripproof motors if satisfactorily housed or remotely located during operation.
 2. Guarded dripproof motors if exposed to contact with employees or building occupants.
- E. Noise Rating: Quiet.
- F. Nameplate: Indicate ratings, characteristics, construction, special features, and full identification of manufacturer.
- G. Starters, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections. Factory wire each fan motor to an electrical junction box mounted on exterior of unit utilizing flexible conduit.
- H. All motors (fans) shall be wired to an electrical termination cabinet mounted on the AHU. Variable frequency controllers shall be provided under Section 23 2963 "Variable Frequency Motor Controllers" and will be field mounted remote from AHUs

2.6 COILS

- A. Coils shall be provided to meet the scheduled performance. Coil performance shall be certified in accordance with ARI Standard 410.
- B. General Water Coils Fabrication:
1. Water coils shall have minimum 1/2 in. OD seamless copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be .035 inches.
 2. Aluminum plate fin type with belled collars.
 3. No turbulence-promoting devices will be permitted inside the tubes.

4. Headers shall be non-ferrous with MPT connections (steel for ferrous piping and red brass for non-ferrous piping). Headers shall have drain and vent connections accessible from the exterior of the unit
5. Coils shall be same end connection and shall be circuited to achieve the maximum pressure drops scheduled.

C. Water Heating Coils:

1. Configuration: Coils shall be drainable, with non-trapping circuits. Working pressure shall be 175 psig at 400 deg F.
2. Coils shall be supplied with die formed casing and tube sheets of minimum 16 gauge mill galvanized steel.

D. Water Cooling Coils:

1. Configuration: Coils shall be drainable, with non-trapping circuits. Working pressure shall be 300 psig at 200 deg. F.
2. Coils shall be supplied with minimum 16 gauge stainless steel casing and tube sheets.
3. Provide condensate drain and trap at cooling coil.

E. Water Coils Source Quality Control:

1. Leak test to 300 psig air pressure.
2. Leak test underwater to 200 psig.

2.7 DAMPERS

- A. General: Unit intake shall have low leakage damper for outdoor air.
- B. Damper Operators: Specified in Section 23 0900 "Instrumentation and Control for HVAC."
- C. Low-Leakage Dampers: Double-skin, airfoil-blade galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals, in parallel-blade arrangement with steel operating rods rotating in stainless-steel sleeve bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg. To eliminate blade warping, dampers shall be sectionalized to limit blade length to 48 inches maximum.

2.8 FILTER SECTIONS

- A. Filters: Specified in Section 23 4100 "Particulate Air Filtration."
- B. Provide filter section with full size gasketed access doors, pre-filters and final filters. Filter track shall run full width of unit and have nylon sliding seals. Filters shall be replaceable from service side of unit.
- C. For each filter section, provide a factory installed Dwyer Model 2003-AF magnahelic air filter gage complete with static pressure tips, adjustable signal flag, tubing and accessories. Mount gage in visible location on the side of Air Handling Unit beside access door to filter section.

2.9 ELECTRICAL SYSTEM

- A. Each unit shall be provided with a factory installed electrical system as follows:
 1. Factory wire interior mounted light fixtures and terminate in a 120 volt, single phase

- service terminal box on the exterior wall of the unit.
- 2. For AHU-226-OG-07, factory wire the supply fan, exhaust fan, and energy recovery wheel for a single 480 Volt, three phase power connection located on the exterior wall of the unit.
- 3. Factory wire each motor through its respective variable frequency controller.
- B. The following work shall be provided under Division 26 in the field.
 - 1. Electrical service wiring to the single point 480 Volt, three phase power connection serving each fans, humidifier and energy wheel, where applicable.
 - 2. Electrical service wiring to the single point 480 Volt, three phase power connection serving each humidifier, where applicable.
 - 3. Electrical service wiring to a single point 120 Volt, single phase power connection serving the interior lights and switches.
- C. Provide all wiring, raceway systems, junction boxes, wiring devices, safety switches, lighting fixtures, panelboards and other electrical components in accordance with the requirements of Division 26, unless more stringent requirements are indicated herein.
- D. Variable Frequency Controllers:
 - 1. Provide variable frequency controllers as specified in Section 23 2923 "Variable-Frequency Motor Controllers." Variable frequency controllers for the project (e.g. fans, pumps) shall be by a single manufacturer.

2.10 SOUND POWER LEVELS

- A. The sound power levels shall not exceed the scheduled values indicated herein when operating throughout its operating range, and maximum design airflow and static pressure conditions scheduled.
- B. Maximum Sound Power Levels, dB re 10E⁻¹² watts:

Maximum Sound Power Levels (dB)	Octave Band Center Frequency (HZ)							
	63	125	250	500	1K	2K	4K	8K
Radiated	76	69	67	64	72	63	50	40
Unit Outlet Connection	92	94	96	89	87	82	77	73
Unit Inlet Connection(s)	90	84	81	79	73	67	58	51

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of hydronic and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Arrange installation of units to provide access space around modular air-handling units for service and maintenance.
- B. Mount indoor units on concrete housekeeping pads. Adjust height as required for installation of condensate piping and traps.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping to allow service and maintenance. Connect condensate drain pans; extend to nearest specialty floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction. Refer to detail on contract drawings.
- C. Comply with applicable requirements in Section 23 2113 "Hydronic Piping." Connect to supply and return coil tapings with piping components as indicated by details on contract drawings.
- D. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. The following are specific connection requirements:
 - 1. Install ducts to termination on unit.
- E. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
- F. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - 1. Leak Test: After installation, fill coils with water and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
 - 2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Participate in Commissioning process. Refer to Commissions specifications.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Final Checks before Startup: Perform the following:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Perform cleaning and adjusting specified in this Section.
 - 4. Lubricate bearings and other moving parts with factory-recommended lubricants.
 - 5. Comb coil fins for parallel orientation.
 - 6. Install clean filters.
 - 7. Verify that manual and automatic volume control and fire dampers in connected duct systems are in fully open position.
 - 8. Check vibration isolation devices for proper operation.
- C. Starting procedures for modular air-handling units include the following:
 - 1. Energize motor; verify proper operation of motor, and fan wheel. Adjust fan to indicated rpm.
 - 2. Measure and record motor electrical values for voltage and amperage.
 - 3. Manually operate dampers from fully closed to fully open position and record fan performance.
- D. Refer to Section 23 0593 "Testing, Adjusting, and Balancing for HVAC" for modular air-handling system testing, adjusting, and balancing.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.

3.7 CLEANING

- A. Clean modular air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face. Remove any elements of rust and restore surfaces and finishes to original condition.
- B. After completing system installation and testing, adjusting, and balancing modular air-handling and air-distribution systems, clean filter housings and install new filters.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain modular air-handling units. Refer to Section 01 7350 "Demonstration and Training."
- B. Contractor is required to train the owner's operation and maintenance personnel. The instruction shall be scheduled in coordination with the Commissioning Agent (CxA) after submission and approval of formal training plans by the CxA. Provide competent, factory

authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed system.

3.9 COMMISSIONING

- A. The air handling units (AHU) shall be commissioned in accordance with Section 01 9113 "General Commissioning Requirements."
- B. The mechanical, controls, and start-up contractors are responsible for supporting all Cx activities and testing as outlined in the Cx Plan. These activities include but are not limited to the following.
 - 1. Respond to all comments provided on the AHU submittals by the Commissioning Agent (CxA).
 - 2. Attend Cx related meetings as outlined in the Cx Plan.
 - 3. Ensure the AHUs are operational in accordance with the contract drawings prior to the start of functional performance testing (FPT).
 - 4. Provide copies of the completed start-up reports and pre-functional checklists to the CxA prior to the start of FPT.
 - 5. Technicians from the start-up, controls, and mechanical contractors are required during all AHU FPT. The start-up technician shall be familiar with the operation of the units and be capable of demonstrating and troubleshooting all required functions.
 - 6. Promptly rectify all AHU related issues that are recorded in the Cx Issues Log. Submit written notification to the Owner, CxA, and Engineer that this has been done. (Note: The CxA, does not provide any directives so any deviation from the original scope must be approved by the Owner or Engineer prior to performing work).

END OF SECTION

SECTION 23 8126

SPLIT-SYSTEM UNITS

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. This Section includes variable capacity split-system cooling units consisting of separate evaporator-fan and compressor-condenser components.
 - 1. Units are designed for exposed mounting.
 - 2. The system shall consist of a matched indoor evaporator units and outdoor units.
 - 3. The outdoor units shall be a direct expansion (DX), air-cooled cooling air-conditioning system, variable speed driven compressor split system.
 - 4. All indoor units shall each be capable of operating separately with individual temperature control.
 - 5. The indoor units shall be connected to the outdoor unit utilizing manufacturer's specified piping joints and headers.
 - 6. The system shall be capable of refrigerant piping lengths indicated on the drawings, without any oil traps or additional equipment.
- B. Related Sections include the following:
 - 1. Section 23 2300 "Refrigerant Piping" for refrigerant piping.
 - 2. Commissioning of equipment or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Commissioning Authority. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure.
 - a. Refer to Section 01 7700 "Closeout Procedures" for substantial completion details.
 - b. Refer to Section 01 9113 "General Commissioning Plan," Section 22 0800 "Commissioning of Plumbing Systems," Section 23 0800 "Commissioning of Mechanical Systems," and Section 26 0800 "Electrical System Commissioning" for detailed commissioning requirements.
 - c. Refer to Section 01 7820 "Operation and Maintenance Data" for operations and maintenance data requirements.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Color Samples for Initial Selection: For units with factory-applied color finishes.

- D. LEED Submittal:
 - 1. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
- G. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. 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.
- B. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
- C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

1.5 COORDINATION

- A. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 7.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard warranty for parts and workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Daikin AC (Americas), Inc.
 - 2. Mitsubishi, Inc.
 - 3. Sanyo Fisher (U.S.A.) Corp.

2.2 EVAPORATOR-FAN COMPONENTS (EXPOSED TYPE)

- A. Configurations:
 - 1. Wall-mounted air conditioning unit.
 - 2. Ceiling-mounted air conditioning unit.
- B. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, auto-swing discharge louver, and discharge drain pans with integral trap and drain connection.

- C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with electronic proportional thermal-expansion valve.
- D. Safeties: Self-diagnostics, auto-restart, 3-minute fused time delay, and test run switch.
- E. Fan: Direct drive, cross-flow.
- F. Fan Motors: Comply with requirements in Section 23 0513 "Common Motor Requirements for Mechanical Equipment."
 - 1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
- G. Filters: Permanent, cleanable.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

- A. General:
 - 1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of a scroll compressor, motors, fans, condenser coil, electronic expansion valve, solenoid valves, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receivers and accumulators.
 - 2. Both liquid and suction lines shall be individually insulated between the outdoor and indoor units.
 - 3. The connection ratio of indoor units to outdoor unit shall be as indicated on the drawings.
 - 4. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for re-programming.
 - 5. The outdoor unit shall be modular in design and allow for side-by-side installation with minimum spacing.
 - 6. The following safety devices shall be included on the condensing unit: high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter, and anti-recycling timers. To ensure the liquid refrigerant does not flash, the circuit shall be provided with a sub-cooling feature. Oil recovery cycle shall be automatic occurring 1 hour after start of operation and then every 6 hours of operation.
- B. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- C. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - 1. Compressor Type: Scroll.
 - 2. The scroll compressor shall be variable speed (PAM inverter) controlled, which is capable of changing the speed to follow the variations in total cooling load, as determined by the suction gas pressure as measured in the condensing unit.
 - 3. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC, hermetically sealed scroll type.
 - 4. The capacity control range shall be 25% to 100%, with 20 individual capacity steps.
 - 5. Refrigerant Charge: R-410A.

- D. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with 2.0-micron thick corrosion treatment.
- E. Fan: Aluminum-propeller type, directly connected to motor.
 - 1. Quantity: Minimum 2
 - 2. Multiple speed, via DC inverter.
- F. Motor: Permanently lubricated, with integral thermal-overload protection.
- G. Low Ambient Kit: Permits cooling operation down to 0 deg F.
- H. Control Wiring:
 - 1. The control voltage between the indoor and outdoor unit shall be 16VDC non-shielded 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 outdoor unit with one 2-cable wire.
- I. Roof Curbs: 0.064-inch aluminum; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit equipment.
 - 1. Configuration: Self-flashing without cant strip, with mounting flange.
 - 2. Overall Height: 18 inches.

2.4 ACCESSORIES

- A. Sensor: Remote mounted, low voltage with subbase to control compressor and evaporator fan.
- B. Integral condensate pump, factory wired and piped.

2.5 CONTROLS

- A. Integral control panel for interface between the indoor evaporator unit and the outdoor condensing unit.
 - 1. BAS Interface: Factory-installed hardware and software to allow the BAS to monitor, control, display and record data for use in preparing reports. Refer to Section 23 0900 "Instrumentation and Control for HVAC" and Section 23 0993 "Sequence of Operations for HVAC Controls."
- B. Auxiliary monitoring and alarm remote space temperature sensor provided by Section 23 0900 "Instrumentation and Control for HVAC" and Section 23 0993 "Sequence of Operations for HVAC Controls."

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.

1. Refer to Section 23 0548 "Mechanical Vibration Control" for vibration isolator requirements.
 - C. Install remote mounted sensors. Provide interconnecting wiring.
 - D. Install ground-mounting, compressor-condenser components on specified support pad. Anchor units to supports.
 - E. Install roof-mounting compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.
 1. Install roof-mounted compressor-condenser components on vibration isolators. Refer to Section 23 0548 "Mechanical Vibration Control".
 - F. Install and connect refrigerant tubing to component's fittings. Install tubing to allow access to unit. Refer to Section 23 2300 "Refrigerant Piping".
- 3.2 CONNECTIONS
- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - B. Install piping adjacent to unit to allow service and maintenance.
 - C. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."
 - D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.
- 3.3 FIELD QUALITY CONTROL
- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
 - B. Perform the following field tests and inspections and prepare test reports:
 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.
 - C. Remove and replace malfunctioning units and retest as specified above.
 - D. System functional performance testing is part of the Commissioning Process. Functional testing shall be performed by the contractor and witnessed and documented by the Commissioning Authority. Refer to Section 01 9113 "General Commissioning Requirements" for system functional tests and commissioning requirements.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
- B. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Section 01 9113 "General Commissioning Requirements," Section 22 0800 "Commissioning of Plumbing Systems," Section 23 0800 "Commissioning of Mechanical Systems," and Section 26 0800 "Electrical System Commissioning" for further details.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Section 01 7350 "Demonstration and Training."
- B. Training of the owner's operation and maintenance personnel is required. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled after submission and approval of formal training plans.
 - 1. Provide certified training to equipment operation and provision of any proprietary service programming and diagnostic equipment for self contained package system
 - 2. Refer to Section 01 7350 "Demonstration and Training" for Contractor training requirements.
- C. Provide competent, factory authorized personnel to support Owner Training of Commissioned systems. This training is in addition to the contractor Owner's training.
 - 1. Refer to Section 01 9113 "General Commissioning Requirements," Section 22 0800 "Commissioning of Plumbing Systems," Section 23 0800 "Commissioning of Mechanical Systems," and Section 26 0800 "Electrical System Commissioning" for further contractor training requirements.

3.6 COMMISSIONING

- A. Provide support for commissioning activities and functional performance testing as outlined in Section 01 9113 "General Commissioning Requirements."

END OF SECTION

SECTION 23 8219

FAN-COIL UNITS

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. This Section includes fan-coil units and accessories.
- B. Related Sections include the following:
 - 1. Commissioning of equipment or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Commissioning Authority. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure.
 - a. Refer to Section 01 7700 "Closeout Procedures" for substantial completion details.
 - b. Refer to Section 01 9113 "General Commissioning Requirements," Section 23 0800 "Commissioning of Mechanical Systems," and Section 26 0800 "Electrical System Commissioning" for detailed commissioning requirements.
 - 2. Section 23 0900 "Instrumentation and Control for HVAC" for controller, control valve and temperature sensors to be factory-installed under this Section.
 - 3. Refer to Section 01 7823 "Operation and Maintenance Data" for operations and maintenance data requirements.

1.3 SUBMITTALS

- A. Product Data: Include specialties and accessories for each unit type and configuration.
- B. Shop Drawings: Submit the following for each fan-coil unit type and configuration:
 - 1. Plans, elevations, sections, and details.
 - 2. Details of anchorages and attachments to structure and to supported equipment.
 - 3. Power, signal, and control wiring diagrams. Differentiate between manufacturer-installed and field-installed wiring.
 - 4. Equipment schedules to include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
- A. Samples for Initial Selection and Verification:
 - 1. Complete factory packaged unit, one for each fan-coil unit type, size, and configuration. Include factory-packaged valving package and factory-installed control system.
 - 2. Manufacturer's color charts showing the full range of colors available for units with factory-applied color finishes.
- B. Field Test Reports: Written reports of tests specified in Part 3 of this Section.

- C. Maintenance Data: For fan-coil units to include in maintenance manuals specified in Division 1. Include the following:
 - 1. Maintenance schedules and repair parts lists for motors, coils, integral controls, and filters.
 - 2. Include completed start-up service documentation and manufacturer's warranty within operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. 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.
- B. Unit capacities certified under Industry Room Fan Coil Air Conditioner Certification Program in accordance with ARI Standard 440.
- C. Capacities: Certified in accordance with ARI Standard 440-97.

1.5 COORDINATION

- A. Coordinate with Section 23 0900 "Instrumentation And Control For HVAC" for factory mounting of DDC controls.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan-Coil-Unit Filters: Furnish one spare filter for each filter installed. Three total filter sets required for each unit. Two sets of filters to be installed by Contractor – one during initial start-up, and one within two weeks after Substantial Completion. The remaining set to be turned-over to Owner where directed.
 - 2. Programmable Thermostats: Furnish twenty.
 - 3. Motors: Furnish ten of each size.
 - 4. Control Valves: Furnish ten of each size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. International Environmental Corp.
 - 2. Daikin Applied.
 - 3. JCI/York International
 - 4. Trane Company (The); North American Commercial Group.

2.2 CONFIGURATION

- A. Description: An assembly including chassis, cabinet, coil, main drain pan, auxiliary drain pan, fan(s), fan motor(s), filter, grille(s), and integral valving and control package suitable for heating and cooling through a 4-pipe type piping system. Factory-packaged and -tested units rated according to ARI 440 and UL 1995.

1. Refer to Drawings for minimum performance and other related features. For non-ducted type units, performance to be based on the completely factory-assembled unit, accounting for the included project-specific features, components and appurtenances.

B. Types:

1. VE: Vertical, exposed, cabinet, floor-mounted, sloped top.
2. VC: Vertical, concealed, floor-mounted with ducted supply connection.
3. HC: Horizontal, concealed above ceiling, with ducted supply and return connections
4. HR: Horizontal, ceiling recessed, with integral return connection and ducted or integral supply connection.

2.3 MATERIALS

A. Chassis: Minimum 18-gage, galvanized steel.

1. Vertical Units: Minimum 3-inch high bottom return air plenum base with four adjustable leveling legs. Minimum adjustment height 0.75-inches.

B. Coil Section Insulation: 1-inch duct liner complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Duct liner and adhesive shall have a maximum flame-spread rating of 25 and smoke-developed rating of 50 when tested according to ASTM E 84.

C. Main and Auxiliary Drain Pans: Insulated, non-corrosive. Fabricate pans and drain connections to comply with ASHRAE 62.1-2004. Drain pans shall be removable.

D. Cabinet: Minimum 16 gage metal panel construction, except stamped grille panels may be minimum 18-gage metal construction and access doors may be minimum 20-gage metal construction. Cabinets are generally galvanized-steel with exposed surfaces painted.

1. Vertical Exposed Units (Type VE and VE-L)
 - a. Front Access Panels: Removable, channel-formed edges, and tamperproof cam fasteners.
 - 1) Galvanized-steel with baked enamel or powder coated finish as selected by Architect from the full range of available colors.
 - b. Sloped or Flat Top: Steel with integral grille for vertical supply air discharge; and two hinged access doors with lockable and tamperproof cam fasteners.
 - c. Return Air Opening: Front, bottom with matching construction and finish as cabinet, and integral grille. Integral grille with matching construction and finish as supply grille, located minimum 0.5-inch above bottom. Horizontally center return grille and secure with tamperproof screws.
 - d. Pipe Entry Openings: Except for rear or bottom inlet conditions where noted on the Drawings, units are piped through the side panel.
 - e. Side Clearance: Maximum 0.5-inch each side for installation, removal and maintenance to edge of solid wall construction indicated on Drawings.
2. Vertical Concealed Units (Type VC):
 - a. Front Access Panels: Removable, galvanized-steel, with channel-formed edges, and tamperproof cam fasteners.
 - b. Supply Air Opening: Ducted, top, suitable for field connection to sill mounted discharge grille.
 - c. Return Air Opening: Front, bottom, near floor level.

3. Horizontal Concealed Units (Type HC):
 - a. Bottom Access Panels: Removable, galvanized-steel, hinged access door with safety chains, filter access panel, channel-formed edges, and tamperproof cam fasteners.
 - b. Supply and Return Air Openings: Ducted, side, suitable for connections to supply and return air devices.
 4. Horizontal Recessed Units (Type HR):
 - a. Bottom Access Panels: Removable, integral stamped return grilles (and supply grilles where indicated on drawings), hinged access doors with safety chains, channel-formed edges, and tamperproof cam fasteners.
 - 1) Galvanized steel with baked enamel or powder coated finish as selected by Architect from the full range of available colors.
 - b. Supply Air Opening: Ducted, side, suitable for connection to supply air device.
 - c. Include variable height inlet collar as required to suit height requirements scheduled for positive condensate drainage.
 - d. Steel recessing flanges for recessing fan-coil units into ceiling.
 5. For units with condensate pumps, include adequate space beneath auxiliary drain pan and within pipe enclosure cabinet to fully conceal the field-installed condensate drain pumps and related piping.
- E. Insulation: Drain pans, and interior surfaces of cabinet thermally and acoustically insulated with nominal 0.5-inch thickness, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C916.
1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- F. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 300 psig and a maximum entering-water temperature of 200 deg F.
1. Include manual air vent at top of each coil and full-size outlet tubing piped to main drain.
 2. End Sheets and Top/Bottom Baffles: Galvanized steel.
- G. Drain Pans: Fabricate pans and drain connections to comply with ASHRAE 62.1-2004 and 2006 International Plumbing Code.
1. Main Drain Pans: Extend the code-required length and width beneath coil; removable; minimum 18-gage stainless steel construction with factory piped NFPA 90A-compliant plastic tubing, or copper tubing connection to the auxiliary drain pan. Include closed-cell foam insulation for the main drain piping and outside surfaces of main drain pan.
 - a. Extend overflow piping from main drain pan to auxiliary drain pan. Alternatively, include water level detection device(s) conforming to UL 508 that will shut-off control valve prior to overflowing main drain pan.
 2. Auxiliary Drain Pans: Extend full length and width beneath factory provided valving and strainer components for coil; removable plastic construction; and minimum 0.5-inch NPT outlet connection. Include closed-cell foam insulation on outside surfaces of auxiliary drain pans.
 - a. Include water level detection device(s) conforming to UL 508 that will shut-off control valve prior to overflowing auxiliary drain pan.
 - b. For Type VE units, locate drain pan outlet connection minimum 8-inches above bottom of unit.

- H. Fan and Motor Board: Removable.
 - 1. Fan: Forward curved, double width, centrifugal; directly connected to motor; aluminum, galvanized-steel, or painted-steel fan wheels and scrolls; dynamically and statically balanced.
 - 2. Motor: Electronically commutated motor (ECM), brushless DC motor, with multi-speed controller and field-adjustable speed settings of Off-Low-Medium-High, integral automatic reset and thermal-overload protection; resiliently mounted on motor board.
 - 3. Wiring Termination: Connect motor to chassis wiring with plug connection.
 - I. Filter: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Pleated Cotton-Polyester Media: Disposable, 1-inch thickness, frame, 90 percent arrestance and MERV 6 rating.
 - J. Factory, Hydronic Valves and Piping Package: ASTM B88, copper tube with wrought-copper fittings and brazed joints. Label piping to indicate coil inlet and outlet. Include integral pipe supports within cabinet and locate above auxiliary drain pan. Locate all valving, vents, drains, and controlled components to be accessible and serviceable.
 - 1. Control Valves and Actuators: Minimum 300-psig working pressure, suitable for operating temperatures from 35 to 200 deg F with minimum close-off differential pressure of 50-psi.
 - a. Factory install control valves and actuators furnished under Section 23 0900 "Instrumentation and Control for HVAC Controls."
 - b. Isolation Valves: Two-piece ball valves; bronze or brass body with chrome-plated bronze or brass ball; teflon seats and packing; 300-psig minimum working pressure; and blowout-proof stems.
 - 2. Automatic Balancing Valves: Bronze or brass; 300-psig minimum working pressure, with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psi; and two integral 0.25-inch pressure/temperature ports with removable depressor type cores and threaded end caps.
 - 3. Y-Pattern Hydronic Strainers: Bronze or brass body; 300-psig minimum working pressure; with soldered connections, bolted cover, perforated 20-mesh stainless-steel basket, and bottom drain connection. Include full size ball type isolation valve in blowdown connection with threaded hose-end type outlet connection and removable threaded plug.
 - 4. Wrought-Copper Unions: ASME B16.22.A.
 - K. Controls: Factory install BacNet controller, return air temperature sensor, supply air temperature sensor, current sensing fan motor relay, chilled water control valve, and heating hot water control valve furnished under Section 23 0900 "Instrumentation and Control for HVAC Controls"
 - L. Capacities and Characteristics: As indicated on Drawings, including pipe entry locations (e.g. left side, right side, right bottom, left bottom, left rear and right rear).
- 2.4 SOURCE QUALITY CONTROL
- A. Test and rate units according to ARI 440.
 - B. Test unit coils according to ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fan-coil units level and plumb.
- B. Install fan-coil units to comply with NFPA 90A.
- C. Suspend fan-coil units from structure with vibration isolators. Vibration isolators are specified in Section 23 0548 "Mechanical Vibration Control."
- D. Protect units during construction activities.
- E. Prior to energizing unit, clean all interior and exterior surfaces.
- F. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect ductwork to units with flexible connectors.
- C. Install piping adjacent to machine to allow service and maintenance.
- D. Ground equipment.
- E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing and report results in writing:
 - 1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safeties.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

- C. The first unit of each type installed shall serve as a mock-up. Mock-up to be commissioned and approved by the UM mechanical inspector prior to installing additional units.
- D. System functional testing is part of the Commissioning Process. Functional testing shall be performed by the contractor and witnessed and documented by the Commissioning Authority. Refer to Section 01 9113 "General Commissioning Requirements" for system functional tests and commissioning requirements.

3.5 CLEANING

- A. After installing units, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. After installing units, clean fan-coil units internally according to manufacturer's written instructions.
- C. Install new filters in each fan-coil unit within two weeks after Substantial Completion.
- D. Clean strainers and replace automatic flow control cartridges in automatic balancing valves as needed to achieve required flow rates at each unit.

3.6 DEMONSTRATION

- A. The fan coil units shall be demonstrated to Owner in all modes of operation. After successful operation is demonstrated, training of maintenance personnel can begin.
- B. Train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units.
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
 - 2. Review data in maintenance manuals. Refer to Section 01 7820 "Operation and Maintenance Data."
 - 3. Schedule training with Owner, through Architect, with at least seven days' advance notice.
- C. Training of the owner's operation and maintenance personnel is required in cooperation with the Commissioning Authority. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Commissioning Authority after submission and approval of formal training plans.
 - 1. Refer to Section 01 7350 "Demonstration and Training" for contractor training requirements.
 - 2. Refer to Section 01 9113 "General Commissioning Requirements," Section 23 0800 "Commissioning of Mechanical Systems," and Section 26 0800 "Electrical System Commissioning" for further contractor training requirements.

3.7 COMMISSIONING

- A. Provide support for commissioning activities and functional performance testing as outlined in Section 01 9113 "General Commissioning Requirements."
- B. Perform pre-functional performance testing and submit report to Commissioning Agent and Owner's Commissioning Representative.

END OF SECTION

SECTION 23 8239

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:
 - 1. Propeller unit heaters with hot-water coils.
- B. Related Sections include the following:
 - 1. Most of the HVAC systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - a. Section 01 9113 "General Commissioning Requirements."

1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. CWP: Cold working pressure.
- C. PTFE: Polytetrafluoroethylene plastic.
- D. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
 - 2. Location and arrangement of piping valves and specialties.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.
- D. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. 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.

PART 2 - PRODUCTS

2.1 PROPELLER UNIT HEATERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Airtherm; a Mestek Company.
 - 2. McQuay International.
 - 3. Trane.
 - 4. Rittling.
- B. Description: An assembly including casing, coil, fan, and motor in horizontal and vertical discharge configurations as indicated by contract drawings with adjustable discharge louvers.
- C. Cabinet: Removable panels for maintenance access to controls.
- D. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.
- E. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.
- F. General Coil Requirements: Test and rate hot-water propeller unit heater coils according to ASHRAE 33.
- G. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.
- H. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- I. Fan Motors: Comply with requirements in Section 23 0513 "Common Motor Requirements for Mechanical Equipment."
 - 1. Motor Type: Permanently lubricated, multispeed.
- J. Control Devices:
 - 1. Thermostat and control valve to be provided by controls contractor and is specified in Section 23 0900 "Instrumentation and Control for HVAC."
 - 2. Provide fan motor starter and disconnect switch with provisions for automatic start/stop control by the Building Automation System.
- K. Electrical Characteristics: Provide unit heater designed for single point electrical connection.
- L. Capacities and Characteristics: Shall be as scheduled on contract drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and 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 propeller unit heaters level and plumb.
- B. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers. Hanger rods and attachments to structure are specified in Section 23 0529 "Hangers and Supports for Mechanical Piping and Equipment." Vibration hangers are specified in Section 23 0548 "Mechanical Vibration Control."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to unit heater to allow service and maintenance.
- C. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Section 23 2113 "Hydronic Piping."
- D. Ground equipment according to Section 26 0526 "Grounding and Bonding Electrical Systems."
- E. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables".

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- B. The first unit of each type installed shall serve as a mock-up. Mock-up to be commissioned and approved by the UM mechanical inspector prior to installing additional units.
- C. Remove and replace malfunctioning units and retest as specified above.

3.5 COMMISSIONING

- A. Most of the HVAC systems are included in the Commissioning Program. Refer to the following specification sections for requirements associated with Commissioning:
 - 1. Section 01 9113 "General Commissioning Requirements".

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain unit heaters. Refer to Section 01 7700 "Closeout Procedures."

END OF SECTION

SECTION 26 0513
MEDIUM-VOLTAGE CABLES

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 cables and related cable splices, terminations, and accessories for medium-voltage (2001 to 35,000 V) electrical distribution systems.

1.3 DEFINITIONS

- A. Jacket: A continuous nonmetallic outer covering for conductors or cables.
- B. NETA ATS: Acceptance Testing Specification.
- C. Sheath: A continuous metallic covering for conductors or cables.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.
- B. Sustainable Design Submittals:
 - 1. **Product Data:** For each conductor and cable indicating lead content.
 - 2. **Product Data:** For solvents and adhesives, indicating VOC content.
 - 3. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Material Certificates: For each type of cable and accessory.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than five days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Owner's written permission.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- 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. Comply with IEEE C2 and NFPA 70.
- C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.2 CABLES

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. Cables:
 - a. **General Cable; General Cable Corporation.**
 - b. **Kerite Co. (The).**
 - c. **Okonite Company (The).**
 - d. **Prysmian Power Cables and Systems USA, LLC.**
- B. Cable Type: Type MV 105.
- C. Conductor Insulation: Ethylene-propylene rubber.
 - 1. Voltage Rating: **[5] [8] [15] [25] [35]** kV.
 - 2. Insulation Thickness: **[100] [133]** percent insulation level.
- D. Conductor: Copper.
- E. Comply with UL 1072, AEIC CS8, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682.
- F. Conductor Stranding: Compact round, concentric lay, Class B.
- G. **Lead Content:** Less than 300 parts per million.

- H. Shielding: Copper tape, helically applied over semiconducting insulation shield.
- I. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together with ground conductors.
 - 1. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.
- J. Cable Sheath: **[Interlocked aluminum] [Interlocked galvanized steel] [Corrugated aluminum tube]** applied over cable.
- K. Cable Jacket: Sunlight-resistant PVC.
- L. Sizes 1/0 AWG and larger shall be listed as "SUN RES for CT-USE." This design shall pass IEEE-1202/FT4 (70,000 BTU/hr).

2.3 CONNECTORS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. **3M.**
 - 2. **Adalet.**
 - 3. **Cooper Power Systems, an Eaton business.**
 - 4. **DSG-Canusa.**
 - 5. **Engineered Products Company.**
 - 6. **G&W Electric Company.**
 - 7. **MP Husky USA Cable Tray & Cable Bus.**
 - 8. **Raychem; TE Connectivity.**
 - 9. **Scott Fetzer Co. (The).**
 - 10. **TE Connectivity Ltd.**
 - 11. **Thomas & Betts Corporation; A Member of the ABB Group.**
- B. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.
- C. Copper-Conductor Connectors: Copper barrel crimped connectors.

2.4 SOLID TERMINATIONS

- A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.
 - 1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.

2.5 SEPARABLE INSULATED CONNECTORS

- A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

- B. Dead-Break Cable Terminators: Elbow-type unit with [200] [600]-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- C. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.
- D. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.6 SPLICE KITS

- A. Description: For connecting medium voltage cables; type as recommended by cable or splicing kit manufacturer for the application.
- B. Standard: Comply with IEEE 404.
- C. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
 - 1. Premolded, cold-shrink-rubber, in-line splicing kit.
 - 2. Premolded, EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

2.7 MEDIUM-VOLTAGE TAPES

- A. Description: Electrical grade, insulating tape rated for medium voltage application.
- B. Ethylene/propylene rubber-based, 30-mil (0.76-mm) splicing tape, rated for 130 deg C operation. Minimum 3/4 inch (20 mm) wide.
- C. Silicone rubber-based, 12-mil (0.30-mm) self-fusing tape, rated for 130 deg C operation. Minimum 1-1/2 inches (38 mm) wide.

2.8 ARC-PROOFING MATERIALS

- A. Description: Fire retardant, providing arc flash protection.
- B. Tape for First Course on Metal Objects: 10-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
- C. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, and compatible with cable jacket.
- D. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1 inch (25 mm) wide.

2.9 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to ICEA S-97-682 before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cables according to IEEE 576, "Recommended Practice for Installation, Termination and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications."
- B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by **48 to 72 inches (1200 to 1800 mm)** on the pull rope.
 - 1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
 - 2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.
- C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - 1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
 - 2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
 - 3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
 - 4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.
- D. Install direct-buried cables on leveled and tamped bed of **3-inch- (75-mm-)** thick, clean sand. Separate cables crossing other cables or piping by a minimum of **2 inches (50 mm)** of tamped earth, plus an additional **2 inches (50 mm)** of sand. Install permanent markers at ends of cable runs, changes in direction, and buried splices.
- E. Install "buried-cable" warning tape **12 inches (305 mm)** above cables.
- F. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.
- G. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.
- H. Install cable splices at pull points and elsewhere as indicated; use standard kits.
- I. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.
- J. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
 2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
 3. Standoff Insulator: At each terminal junction, with one on each terminal.
- K. [Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:**
1. Clean cable sheath.
 2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
 3. Smooth surface contours with electrical insulation putty.
 4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
 5. Band arc-proofing tape with two layers of 1-inch- (25-mm-) wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.]
- L. Seal around cables passing through fire-rated elements according to Section 07 8413 "Penetration Firestopping."
- M. Install fault indicators on each phase where indicated.
- N. Ground shields of shielded cable at one point only. Maintain shield continuity and connections to metal connection hardware at all connection points.
- O. Identify cables according to Section 26 0553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.
- 3.2 FIELD QUALITY CONTROL
- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
- C. Medium-voltage cables will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 26 0513

SECTION 26 0519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Copper building wire rated 600 V or less.
2. **[Aluminum building wire rated 600 V or less.]**
3. **[Metal-clad cable, Type MC, rated 600 V or less.]**
4. **[Photovoltaic cable, Type PV, rated 2000 V or less.]**
5. **[Mineral-insulated cable, Type MI, rated 600 V or less.]**
6. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. **[Section 26 0513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35,000 V.]**
2. **[Section 26 0523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.]**

1.3 DEFINITIONS

- A. **[PV: Photovoltaic.]**
- B. **[RoHS: Restriction of Hazardous Substances.]**
- C. **[VFC: Variable-frequency controller.]**

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. **Product Data:** For each conductor and cable indicating lead content.
2. **Product Data:** For recycled content, indicating postconsumer and preconsumer recycled content and cost.
3. **Product Data:** For solvents and adhesives, indicating VOC content.

- C. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. Cerro Wire LLC.
 - 2. General Cable Technologies Corporation.
 - 3. Service Wire Co.
 - 4. Southwire Company.
- C. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. **[RoHS compliant.]**
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Conductor Insulation:
 - 1. Type USE-2 and Type SE: Comply with UL 854.
 - 2. **[Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.]**
 - 3. Type THHN and Type THWN(-2): Comply with UL 83.
 - 4. Type UF: Comply with UL 83 and UL 493.
 - 5. **[Type XHHW-2: Comply with UL 44.]**
- F. Shield:
 - 1. **[Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, [spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire] [dual spirally wrapped copper tape**

shields and three bare symmetrically applied ground wires], and sunlight- and oil-resistant outer PVC jacket.]

2.2 [ALUMINUM BUILDING WIRE

- A. **Description:** Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. **Standards:**
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. **Conductor and Cable Marking:** Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. **Conductors:** Aluminum, complying with ASTM B 800 and ASTM B 801.
- D. **Conductor Insulation:**
 - 1. [Type USE-2] [and] [Type SE]: Comply with UL 854.
 - 2. [Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.]
 - 3. Type THHN and Type THWN(-2): Comply with UL 83.
 - 4. Type XHHW-2: Comply with UL 44.]

2.3 [METAL-CLAD CABLE, TYPE MC

- A. **Description:** A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. **General Cable Technologies Corporation.**
 - 2. **Service Wire Co.**
 - 3. **Southwire Company.**
- C. **Standards:**
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. Comply with UL 1569.
 - 3. **Conductor and Cable Marking:** Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. **Circuits:**
 - 1. Single circuit.
 - 2. **Power-Limited Fire-Alarm Circuits:** Comply with UL 1424.
- E. **Conductors:** Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. **Ground Conductor: Insulated.**

G. **Conductor Insulation:**

1. **Type TFN/THHN/THWN: Comply with UL 83.**
2. **Type XHHW-2: Comply with UL 44.**

H. **Armor: Steel, interlocked.**

I. **Jacket: PVC applied over armor.]**

2.4 [PHOTOVOLTAIC CABLE, TYPE PV

A. **Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated [2000] [600] V.**

B. **Standards:**

1. **Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.**
2. **Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."**

C. **Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.**

D. **Conductor Insulation: Comply with UL 44 and UL 4703.]**

2.5 [MINERAL-INSULATED CABLE, TYPE MI

A. **Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, rated 600 V or less.**

B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. **KME America, Inc.**
2. **Pentair.**
3. **Watlow Electric Manufacturing.**

C. **Standards:**

1. **Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.**
2. **UL 2196 for fire resistance.**
3. **Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."**

D. **Conductors: Copper, complying with ASTM B 3 for bare annealed copper.**

E. **Insulation: Compressed magnesium oxide.**

F. Sheath: Copper.]

2.6 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. **3M Electrical Products.**
 2. **Hubbell Power Systems, Inc.**
 3. **Ideal Industries, Inc.**
 4. **O-Z/Gedney; a brand of Emerson Industrial Automation.**
 5. Tyco Electronics.
 6. Thomas & Betts Corporation.
- C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
1. Material: Copper.
 2. Type: Two hole with **[standard] [long]** barrels.
 3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. [VFC Output Circuits Cable: Extra-flexible stranded for all sizes.]**
- D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.
- E. PV Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: **[Type THHN/THWN(-2), single conductors in raceway] [Type USE, single conductor in raceway] [Mineral-insulated, metal-sheathed cable, Type MI].**
- B. Exposed Feeders: **[Type THHN/THWN(-2), single conductors in raceway] [Mineral-insulated, metal-sheathed cable, Type MI].**

- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawspaces: **[Type THHN/THWN(-2), single conductors in raceway] [Metal-clad cable, Type MC].**
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: **[Type THHN/THWN(-2), single conductors in raceway] [Type XHHW-2, single conductors in raceway] [Underground feeder cable, Type UF].**
- E. Feeders Installed below Raised Flooring: **[Type THHN/THWN(-2), single conductors in raceway].**
- F. Feeders in Cable Tray: **[Type THHN/THWN(-2), single conductors in raceway] [Type XHHW-2, single conductors larger than No. 1/0 AWG] [Metal-clad cable, Type MC] [Mineral-insulated, metal-sheathed cable, Type MI].**
- G. Exposed Branch Circuits, Including in Crawspaces: **[Type THHN/THWN(-2), single conductors in raceway] [Metal-clad cable, Type MC].**
- H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: **[Type THHN/THWN(-2), single conductors in raceway] [Metal-clad cable, Type MC].**
- I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: **[Type THHN/THWN(-2), single conductors in raceway] [Type XHHW-2, single conductors in raceway].**
- J. Branch Circuits Installed below Raised Flooring: **[Type THHN/THWN(-2), single conductors in raceway] [Metal-clad cable, Type MC] [Mineral-insulated, metal-sheathed cable, Type MI].**
- K. Branch Circuits in Cable Tray: **[Type THHN/THWN(-2), single conductors in raceway] [Type XHHW-2, single conductors larger than No. 1/0 AWG] [Metal-clad cable, Type MC] [Mineral-insulated, metal-sheathed cable, Type MI].**
- L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- M. VFC Output Circuits: **[Type XHHW-2 in metal conduit] [Type TC-ER cable with dual tape shield].**
- N. PV Circuits: Type USE-2 for PV source circuits rated at 600 V or less.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and under floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 26 0533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 26 0529 "Hangers and Supports for Electrical Systems."
- G. **[Complete cable tray systems installation according to Section 26 0536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.]**

3.4 [WIRING FOR LIGHTING FIXTURES AND RECEPTACLES

- A. **Type MC cable shall be allowed for connections within a room from a junction box above the ceiling to the lighting fixtures.**
- B. **Branch circuit home runs shall be in EMT from panelboard to junction box above ceiling.**
- C. **Type MC cable shall be allowed from a junction box above the ceiling within a room of the receptacle sin the same room.**
- D. **Type MC cable shall not be allowed to cross one room to another room whether the wall between two rooms goes up to slab or not. If the rooms are identified as two separate rooms, Type MC cable shall not be used between the two rooms.**
- E. **Type MC cable shall not be used between two receptacles when they are in two separate rooms, on the same wall.]**

3.5 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material[**and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors**].
 - 1. **[Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.]**
- C. Wiring at Outlets: Install conductor at each outlet, with at least **6 inches (150 mm)** of slack.

3.6 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 0553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 0544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 8413 "Penetration Firestopping."

3.9 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. Perform tests and inspections.
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. After installing conductors and cables and before electrical circuitry has been energized, test **[service entrance and feeder conductors] [and] [conductors]** feeding the following critical equipment and services for compliance with requirements:
 - a. **<Insert, in separate subparagraphs, critical equipment and services to be tested>.**
 - 3. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
 - 4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

- a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
- D. Cables will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports to record the following:
1. Procedures used.
 2. Results that comply with requirements.
 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 0519

SECTION 26 0526

GROUNDING AND BONDING FOR ELECTRICAL 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 grounding and bonding systems and equipment.
- B. Section includes grounding and bonding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Ground bonding common with lightning protection system.
 - 3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Ground rings.
 - 4. Grounding arrangements and connections for separately derived systems.
- B. Qualification Data: For testing agency and testing agency's field supervisor.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding 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. Instructions for periodic testing and inspection of grounding features at **[test wells]** **[ground rings]** **[grounding connections for separately derived systems]** **<Insert locations>** based on **[NETA MTS]** **[NFPA 70B]** **<Insert reference>**.

- 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
- 2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. **Burndy; Part of Hubbell Electrical Systems.**
 2. **ERICO International Corporation.**
 3. **Fushi Copperweld Inc.**
 4. **Harger Lightning and Grounding.**
 5. **ILSCO.**
 6. **O-Z/Gedney; A Brand of the EGS Electrical Group.**
 7. **Robbins Lightning, Inc.**
 8. **Siemens Power Transmission & Distribution, Inc.**
 9. **Blackburn; Thomas & Betts.**
 10. **Crouse Hinds; Eaton.**

2.2 SYSTEM DESCRIPTION

- 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. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

- A. Insulated Conductors: **[Copper] [or] [tinned-copper]** wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 1. Solid Conductors: ASTM B 3.
 2. Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.
 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, **1/4 inch (6 mm)** in diameter.
 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; **1-5/8 inches (41 mm)** wide and **1/16 inch (1.6 mm)** thick.
 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; **1-5/8 inches (41 mm)** wide and **1/16 inch (1.6 mm)** thick.

- C. Grounding Bus: Predrilled rectangular bars of annealed copper, [**1/4 by 4 inches (6.3 by 100 mm)**] <Insert dimensions> in cross section, with **9/32-inch (7.14-mm)** holes spaced **1-1/8 inches (28 mm)** apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Cable Tray Ground Clamps: Mechanical type, zinc-plated malleable iron.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.
- H. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- I. Straps: Solid copper, [**cast-bronze clamp**] [**copper lugs**]. Rated for 600 A.
- J. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal [**one**] [**two**]-piece clamp.
- K. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- L. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with [**zinc-plated**] [**stainless-steel**] bolts.
 - a. Material: [**Tin-plated aluminum**] [**Die-cast zinc alloy**].
 - b. Listed for direct burial.
 - 2. U-bolt type with malleable-iron clamp and [**copper ground connector**] [**copper ground connector rated for direct burial**].

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; **3/4 inch by 10 feet (19 mm by 3 m)**.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare **[tinned-]**copper conductor, No. 4/0 AWG minimum.
 - 1. Bury at least **24 inches (600 mm)** below grade.
 - 2. Duct-Bank Grounding Conductor: Bury **12 inches (300 mm)** above duct bank when indicated as part of duct-bank installation.
- C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers **2 inches (50 mm)** minimum from wall, **6 inches (150 mm)** above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
- D. 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: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUND VFC CONTROLLED MOTORS

- A. VFC Controlled Motors: Install high frequency grounding straps from motor frame to ground.

3.5 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so **4 inches (100 mm)** will extend 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 (50 mm)** above to **6 inches (150 mm)** below concrete. Seal floor opening with waterproof, nonshrink grout.

- C. 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, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than **6 inches (150 mm)** from the foundation.

3.6 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. **[X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.]**
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. **[Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.]**

- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- G. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
- H. Metallic Fences: Comply with requirements of IEEE C2.
 - 1. Grounding Conductor: Bare[, tinned] copper, not less than No. 8 AWG.
 - 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
 - 3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.7 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are **2 inches (50 mm)** below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least **12 inches (300 mm)** deep, with cover.
 - 1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install **[tinned]** bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than **60 feet (18 m)** apart.
- I. **[Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building].**
1. **[Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.]**
 2. **[Bury ground ring not less than **[24 inches (600 mm)]** from building's foundation.]**
- J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of **20 feet (6 m)** of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than **20 feet (6 m)** long, coil excess conductor within base of foundation.
 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
- K. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least **20 feet (6.0 m)** long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.
- 3.8 FIELD QUALITY CONTROL
- A. Perform tests and inspections.

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal[, **at ground test wells**][, **and at individual ground rods**]. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- B. Grounding system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
 5. Substations and Pad-Mounted Equipment: 5 ohms.
 6. Manhole Grounds: 10 ohms.
- E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 0526

SECTION 26 0529

HANGERS AND SUPPORTS FOR ELECTRICAL 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. Steel slotted support systems.
2. Aluminum slotted support systems.
3. Nonmetallic slotted support systems.
4. Conduit and cable support devices.
5. Support for conductors in vertical conduit.
6. Structural steel for fabricated supports and restraints.
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

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. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum **13/32-inch-**
(10-mm-) diameter holes at a maximum of **8 inches (200 mm)** o.c. in at least one surface.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. **Allied Tube & Conduit; a part of Atkore International.**
 - b. **Cooper B-Line, Inc.; a division of Cooper Industries.**
 - c. **ERICO International Corporation.**
 - d. **Thomas & Betts Corporation; A Member of the ABB Group.**
 - e. **Unistrut; Part of Atkore International.**
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Material for Channel, Fittings, and Accessories: **[Galvanized steel] [Plain steel] [Stainless steel, Type 304] [Stainless steel, Type 316].**
 4. Channel Width: Selected for applicable load criteria.
 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1) **Hilti, Inc.**

- 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co.
2. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [stainless] steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
- a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti, Inc.
 - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Cooper B-Line, Inc.; a division of Cooper Industries.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 05 5000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA 1, "Standard Practice for Good Workmanship in Electrical Construction."
 2. NECA 101, "Standard for Installing Steel Conduits."
 3. **[NECA 102, "Standard for Installing Aluminum Regid Metal Conduit."]**
 4. **[NECA 105, "Standard for Installing Metal Cable Tray Systems."]**
- B. Comply with requirements in Section 07 8413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 26 0533 "Raceways and Boxes for Electrical Systems."

- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be **1/4 inch (6 mm)** in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, according to NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus **200 lb (90 kg)**.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete **4 inches (100 mm)** thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than **4 inches (100 mm)** thick.
 - 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 05 5000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 [CONCRETE BASES

- A. **Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.**
- B. **Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in [Section 03 3000 "Cast-in-Place Concrete."] [Section 03 3053 "Miscellaneous Cast-in-Place Concrete."]**
- C. **Anchor equipment to concrete base as follows:**
 - 1. **Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.**
 - 2. **Install anchor bolts to elevations required for proper attachment to supported equipment.**
 - 3. **Install anchor bolts according to anchor-bolt manufacturer's written instructions.]**

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.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of **2.0 mils (0.05 mm)**.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 0529

SECTION 26 0533

RACEWAYS AND BOXES FOR ELECTRICAL 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. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. **[Handholes and boxes for exterior underground cabling.]**

- B. Related Requirements:

1. Section 07 8413 "Penetration Firestopping" for firestopping at conduit and box entrances.
2. Section 26 0543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
3. Section 27 0528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.3 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

- B. Sustainable Design Submittals:

1. **Product Data:** For solvents and adhesives, indicating VOC content.
2. **Laboratory Test Reports:** For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

- C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

- A. **[Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:**
1. **Structural members in paths of conduit groups with common supports.**
 2. **HVAC and plumbing items and architectural features in paths of conduit groups with common supports.]**

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. AFC Cable Systems; a part of Atkore International.
 - b. Allied Tube & Conduit; a part of Atkore International.
 - c. Anamet Electrical, Inc.
 - d. Calconduit.
 - e. Electri-Flex Company.
 - f. FSR Inc.
 - g. Korkap.
 - h. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - i. Patriot Aluminum Products, LLC.
 - j. Perma-Cote.
 - k. Picoma Industries, Inc.
 - l. Republic Conduit.
 - m. Southwire Company.
 - n. Thomas & Betts Corporation; A Member of the ABB Group.
 - o. Topaz Electric; a division of Topaz Lighting Corp.
 - p. Western Tube and Conduit Corporation.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. GRC: Comply with ANSI C80.1 and UL 6.
4. EMT: Comply with ANSI C80.3 and UL 797.
5. FMC: Comply with UL 1; zinc-coated steel.
6. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. AFC Cable Systems; a part of Atkore International.
 - b. Allied Tube & Conduit; a part of Atkore International.
 - c. Anamet Electrical, Inc.
 - d. Calconduit.

- e. **Electri-Flex Company.**
 - f. **FSR Inc.**
 - g. **Opti-Com Manufacturing Network, Inc (OMNI).**
 - h. **O-Z/Gedney; a brand of Emerson Industrial Automation.**
 - i. **Patriot Aluminum Products, LLC.**
 - j. **Picoma Industries, Inc.**
 - k. **Republic Conduit.**
 - l. **Southwire Company.**
 - m. **Thomas & Betts Corporation; A Member of the ABB Group.**
 - n. **Topaz Electric; a division of Topaz Lighting Corp.**
 - o. **Western Tube and Conduit Corporation.**
- 2. Comply with NEMA FB 1 and UL 514B.
 - 3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 4. Fittings, General: Listed and labeled for type of conduit, location, and use.
 - 5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 - 6. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Compression.
 - 7. Expansion Fittings: Steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- C. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

- 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. **AFC Cable Systems; a part of Atkore International.**
 - b. **Anamet Electrical, Inc.**
 - c. **Arnco Corporation.**
 - d. **CANTEX INC.**
 - e. **CertainTeed Corporation.**
 - f. **Condux International, Inc.**
 - g. **Electri-Flex Company.**
 - h. **FRE Composites.**
 - i. **Kraloy.**
 - j. **Lamson & Sessions.**
 - k. **Niedax Inc.**
 - l. **RACO; Hubbell.**
 - m. **Thomas & Betts Corporation; A Member of the ABB Group.**
 - n. **Topaz Electric; a division of Topaz Lighting Corp.**

2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. ENT: Comply with NEMA TC 13 and UL 1653.
4. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
5. LFNC: Comply with UL 1660.

B. Nonmetallic Fittings:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. AFC Cable Systems; a part of Atkore International.
 - b. Anamet Electrical, Inc.
 - c. Arnco Corporation.
 - d. CANTEX INC.
 - e. CertainTeed Corporation.
 - f. Condux International, Inc.
 - g. Electri-Flex Company.
 - h. FRE Composites.
 - i. Kraloy.
 - j. Lamson & Sessions.
 - k. Niedax Inc.
 - l. RACO; Hubbell.
 - m. Thomas & Betts Corporation; A Member of the ABB Group.
 - n. Topaz Electric; a division of Topaz Lighting Corp.
2. Fittings, General: Listed and labeled for type of conduit, location, and use.
3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
 - a. Fittings for LFNC: Comply with UL 514B.
4. Solvents and Adhesives: As recommended by conduit manufacturer.
5. Adhesive shall 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."

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 1. B-line, an Eaton business.
 2. Hoffman; a brand of Pentair Equipment Protection.
 3. MonoSystems, Inc.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
 - D. Wireway Covers: Screw-cover type unless otherwise indicated.
 - E. Finish: Manufacturer's standard enamel finish.
- 2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS
- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 1. **Allied Moulded Products, Inc.**
 2. **Hoffman; a brand of Pentair Equipment Protection.**
 3. **Lamson & Sessions.**
 - B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
 - D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
 - E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
 - F. Solvents and Adhesives: As recommended by conduit manufacturer.
 1. **VOC Content:** [510] [490] <Insert value> g/L or less for [PVC] [CPVC] conduit and fittings.
 2. **Low-Emitting Material Requirements:** As recommended by solvent and adhesive manufacturer and that 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 SURFACE RACEWAYS
- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
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. Hubbell Incorporated; Wiring Device-Kellems.
 - b. MonoSystems, Inc.
 - c. Panduit Corp.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated.
 - b. MonoSystems, Inc.
 - c. Panduit Corp.
- D. Tele-Power Poles:
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. MonoSystems, Inc.
 - b. Panduit Corp.
 2. Material: Galvanized steel with ivory baked-enamel finish.
 3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. Adalet.
 2. Crouse-Hinds, an Eaton business.
 3. EGS/Appleton Electric.
 4. Erickson Electrical Equipment Company.
 5. FSR Inc.
 6. Hoffman; a brand of Pentair Equipment Protection.
 7. Hubbell Incorporated.
 8. Hubbell Incorporated; Wiring Device-Kellems.
 9. Kraloy.
 10. Milbank Manufacturing Co.

11. MonoSystems, Inc.
 12. Oldcastle Enclosure Solutions.
 13. O-Z/Gedney; a brand of Emerson Industrial Automation.
 14. Plasti-Bond.
 15. RACO; Hubbell.
 16. Spring City Electrical Manufacturing Company.
 17. Stahlin Non-Metallic Enclosures.
 18. Thomas & Betts Corporation; A Member of the ABB Group.
 19. Topaz Electric; a division of Topaz Lighting Corp.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Metal Floor Boxes:
1. Material: **[Cast metal] [or] [sheet metal]**.
 2. Type: **[Fully adjustable] [Semi-adjustable]**.
 3. Shape: Rectangular.
 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. **[Nonmetallic Floor Boxes: Nonadjustable, [round] [rectangular].**
1. **Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.]**
- G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing **50 lb (23 kg)**. Outlet boxes designed for attachment of luminaires weighing more than **50 lb (23 kg)** shall be listed and marked for the maximum allowable weight.
- H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing **70 lb (32 kg)**.
1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- I. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- K. Device Box Dimensions: **4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep)**.
- L. Gangable boxes are allowed.

- M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Fiberglass.
 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- N. Cabinets:
1. NEMA 250, [**Type 1**] [**Type 3R**] [**Type 12**] galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.
 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 [HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING]

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. **Armorcast Products Company.**
 - b. **NewBasis.**
 - c. **Oldcastle Enclosure Solutions.**
 - d. **Oldcastle Precast, Inc.**
2. **Standard:** Comply with SCTE 77.
3. **Configuration:** Designed for flush burial with integral closed bottom unless otherwise indicated.
4. **Cover:** Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. **Cover Finish:** Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. **Cover Legend:** Molded lettering, "ELECTRIC."
7. **Conduit Entrance Provisions:** Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. **Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger:** Have inserts for cable racks and pulling-in irons installed before concrete is poured.]

2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: **[GRC] [RNC, Type EPC-40-PVC]**.
 2. Concealed Conduit, Aboveground: **[GRC] [EMT] [RNC, Type EPC-40-PVC]**.
 3. Underground Conduit: RNC, **[Type EPC-40-PVC]**, **[direct buried] [concrete encased]**.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LPMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LPMC in damp or wet locations.
 6. Damp or Wet Locations: GRC.
 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: **3/4-inch (21-mm)** trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.

3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- G. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION

- A. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least **6 inches (150 mm)** away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within **12 inches (300 mm)** of changes in direction.
- I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within **12 inches (300 mm)** of enclosures to which attached.
- L. Raceways shall not be embedded in slabs:
 - 1. No conduits shall be run in concrete slab unless specifically indicated on the electrical drawings.
 - 2. Aluminum conduit is not permitted to be embedded in concrete slabs.
 - 3. When conduits are allowed embedded in concrete slabs the following apply:

- a. Conduits in concrete slabs must be spaced such that the distance between conduits, centerline to centerline, is a minimum of three times the outside diameter of the largest conduit.
 - b. No conduit may be placed in the concrete slab which has an outside diameter larger than one-third the total slab thickness.
 - c. Conduit shall be placed in the middle one-third of the slab thickness.
 - d. Conduits which cross one another in the concrete slab shall not consume a total space at the point of crossover that is greater than one-third the total slab thickness.
 - e. Conduit embedded in slabs shall not pass through cages.
4. When conduit is to be placed in the slab, the Contractor must advise the Structural Engineer of the number of conduits to be placed and indicate proposed method of installation for the conduits. No conduit shall be placed without the Structural Engineer's approval.
- M. Stub-ups to Above Accessible Ceilings:
1. Use EMT or RMC for raceways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to **1-1/4-inch (35mm)** trade size and insulated throat metal bushings on **1-1/2-inch (41-mm)** trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- P. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- Q. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- R. Cut conduit perpendicular to the length. For conduits **2-inch (53-mm)** trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- S. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than **200-lb (90-kg)** tensile strength. Leave at least **12 inches (300 mm)** of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- T. Surface Raceways:
1. Install surface raceway with a minimum **2-inch (50-mm)** radius control at bend points.
 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding **48 inches (1200 mm)** and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

- U. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, 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 according to NFPA 70.
- V. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Conduit extending from interior to exterior of building.
 - 4. Where otherwise required by NFPA 70.
- W. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- X. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed **30 deg F (17 deg C)** and that has straight-run length that exceeds **25 feet (7.6 m)**. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed **100 deg F (55 deg C)** and that has straight-run length that exceeds **100 feet (30 m)**.
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: **125 deg F (70 deg C)** temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: **155 deg F (86 deg C)** temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: **125 deg F (70 deg C)** temperature change.
 - d. Attics: **135 deg F (75 deg C)** temperature change.
 - 3. Install fitting(s) that provide expansion and contraction for at least **0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C)** of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least **0.00078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C)** of temperature change for metal conduits.
 - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- Y. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of **72 inches (1830 mm)** of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations subject to severe physical damage.
 - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

- Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- BB. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- CC. Locate boxes so that cover or plate will not span different building finishes.
- DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- FF. Set metal floor boxes level and flush with finished floor surface.
- GG. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
 - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 2000 "Earth Moving" for pipe less than **6 inches (150 mm)** in nominal diameter.
 - 2. Install backfill as specified in Section 31 2000 "Earth Moving."
 - 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within **12 inches (300 mm)** of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 2000 "Earth Moving."
 - 4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with **3 inches (75 mm)** of concrete for a minimum of **12 inches (300 mm)** on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of **60 inches (1500 mm)** from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
 - 5. Underground Warning Tape: Comply with requirements in Section 26 0553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from **1/2-inch (12.5-mm)** sieve to **No. 4 (4.75-mm)** sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures **1 inch (25 mm)** above finished grade.
- D. Install handholes with bottom below frost line, **30 inches (762 mm)** below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 0544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 8413 "Penetration Firestopping."

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 26 0533

SECTION 26 0543

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL 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. Metal conduits and fittings, including GRC.
2. Rigid nonmetallic duct.
3. Flexible nonmetallic duct.
4. Duct accessories.
5. Precast concrete handholes.
6. Polymer concrete handholes and boxes with polymer concrete cover.
7. Fiberglass handholes and boxes with polymer concrete cover.
8. Fiberglass handholes and boxes.
9. High-density plastic boxes.
10. Precast manholes.
11. Cast-in-place manholes.
12. Utility structure accessories.

1.3 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
 1. Two or more ducts installed in parallel, with or without additional casing materials.
 2. Multiple duct banks.
- D. GRC: Galvanized rigid (steel) conduit.
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include duct-bank materials, including spacers and miscellaneous components.

2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 3. Include accessories for manholes, handholes, boxes.
 4. Include underground-line warning tape.
- B. Shop Drawings:
1. Precast or Factory-Fabricated Underground Utility Structures:
 - a. Include plans, elevations, sections, details, attachments to other work, and accessories.
 - b. Include duct entry provisions, including locations and duct sizes.
 - c. Include reinforcement details.
 - d. Include frame and cover design and manhole chimneys.
 - e. Include ladder details.
 - f. Include grounding details.
 - g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - h. Include joint details.
 2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
 - a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
 - b. Include duct entry provisions, including locations and duct sizes.
 - c. Include cover design.
 - d. Include grounding details.
 - e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
- C. Sustainable Design Submittals:
1. **Product Data:** For adhesives and sealants, indicating VOC content.
 2. **Laboratory Test Reports:** For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
- 1.5 INFORMATIONAL SUBMITTALS
- A. Product Certificates: For concrete and steel used in precast concrete [**manholes**] [**and**] [**handholes**], as required by ASTM C 858.
 - B. Source quality-control reports.
 - C. Field quality-control reports.
- 1.6 MAINTENANCE MATERIALS SUBMITTALS
- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify **[Architect]** **[Construction Manager]** **[Owner]** no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without **[Architect's]** **[Construction Manager's]** **[Owner's]** written permission.
- B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.
- C. Ground Water: Assume ground-water level is **36 inches (900 mm)** below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems; a part of Atkore International.
 - 2. Allied Tube & Conduit; a part of Atkore International.
 - 3. Anamet Electrical, Inc.
 - 4. Calconduit.
 - 5. Electri-Flex Company.
 - 6. FSR Inc.
 - 7. Korkap.
 - 8. Opti-Com Manufacturing Network, Inc (OMNI).
 - 9. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 10. Perma-Cote.
 - 11. Picoma Industries, Inc.
 - 12. Plasti-Bond.
 - 13. Republic Conduit.
 - 14. Southwire Company.
 - 15. Thomas & Betts Corporation; A Member of the ABB Group.
 - 16. Topaz Electric; a division of Topaz Lighting Corp.
 - 17. Western Tube and Conduit Corporation.
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

- A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

- B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. Beck Manufacturing.
 - 2. CANTEX INC.
 - 3. CertainTeed Corporation.
 - 4. Condux International, Inc.
 - 5. Electri-Flex Company.
 - 6. Lamson & Sessions.
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
- D. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 DUCT ACCESSORIES

- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. CANTEX INC.
 - c. Carlon; a brand of Thomas & Betts Corporation.
 - d. IPEX USA LLC.
 - e. PenCell Plastics.
- B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 26 0553 "Identification for Electrical Systems."

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
- B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. Carder Concrete Products.
 - 2. Christy Concrete Products.
 - 3. Elmhurst-Chicago Stone Co.
 - 4. Oldcastle Precast, Inc.
 - 5. Riverton Concrete Products.
 - 6. Utility Concrete Products, LLC.
 - 7. Utility Vault Co.
 - 8. A.C. Miller
- C. Comply with ASTM C 858 for design and manufacturing processes.

- D. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- E. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- F. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
 - 1. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - 2. Cover Handle: Recessed.
- G. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
 - 1. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - 2. Cover Handle: Recessed.
- H. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- I. Cover Legend: Molded lettering, ["**ELECTRIC.**"] [**as indicated for each service.**]
- J. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.
- K. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - 1. Extension shall provide increased depth of **12 inches (300 mm)**.
 - 2. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
- L. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- M. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional **12 inches (300 mm)** vertically and horizontally to accommodate alignment variations.
 - 1. [**Splayed**] [**Center window**] location.
 - 2. Knockout panels shall be located no less than **6 inches (150 mm)** from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - 3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
 - 4. Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 - 5. Knockout panels shall be **1-1/2 to 2 inches (38 to 50 mm)** thick.
- N. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - 1. Type and size shall match fittings to duct to be terminated.

2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.

O. Handholes **12 inches wide by 24 inches long (300 mm wide by 600 mm long)** and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.5 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. Christy Concrete Products.
2. Elmhurst-Chicago Stone Co.
3. Oldcastle Precast, Inc.
4. Rinker Group, Ltd.
5. Riverton Concrete Products.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: **[Gray] [Green]**.

E. Configuration: Units shall be designed for flush burial and have **[open] [integral closed]** bottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, "ELECTRIC."

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes **12 inches wide by 24 inches long (300 mm wide by 600 mm long)** and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.6 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER

A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

- B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. Carson Industries LLC.
 - 2. Christy Concrete Products.
 - 3. Nordic Fiberglass, Inc.
 - C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
 - D. Color: **[Gray]** **[Green]**.
 - E. Configuration: Units shall be designed for flush burial and have **[open]** **[integral closed]** bottom unless otherwise indicated.
 - F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - H. Cover Legend: Molded lettering, "ELECTRIC."
 - I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
 - J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
 - K. Handholes **12 inches wide by 24 inches long** (**300 mm wide by 600 mm long**) and larger shall have factory-installed inserts for cable racks and pulling-in irons.
- 2.7 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER
- A. Description: Molded of fiberglass-reinforced polyester resin, with covers made of **[polymer concrete]** **[reinforced concrete]** **[cast iron]** **[hot-dip galvanized-steel diamond plate]** **[fiberglass]**.
 - B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. Carson Industries LLC.
 - 2. Christy Concrete Products.
 - 3. Nordic Fiberglass, Inc.
 - C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
 - D. Color: **[Gray]** **[Green]**.

- E. Configuration: Units shall be designed for flush burial and have **[open] [integral closed]** bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, "ELECTRIC."
- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes **12 inches wide by 24 inches long (300 mm wide by 600 mm long)** and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.8 FIBERGLASS HANDHOLES AND BOXES

- A. Description: Molded of fiberglass-reinforced polyester resin, with covers made of **[polymer concrete] [reinforced concrete] [cast iron] [hot-dip galvanized-steel diamond plate] [fiberglass]**.
- B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. **Carson Industries LLC.**
 - 2. **Christy Concrete Products.**
 - 3. **Nordic Fiberglass, Inc.**
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: **[Gray] [Green]**.
- E. Configuration: Units shall be designed for flush burial and have **[open] [integral closed]** bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, "ELECTRIC."
- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes **12 inches wide by 24 inches long (300 mm wide by 600 mm long)** and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.9 HIGH-DENSITY PLASTIC BOXES

- A. Description: Injection molded of HDPE or copolymer-polypropylene. Cover shall be made of **[polymer concrete] [hot-dip galvanized-steel diamond plate] [plastic]**.
- B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. **Carson Industries LLC.**
 - 2. **Nordic Fiberglass, Inc.**
 - 3. **PenCell Plastics.**
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: **[Gray] [Green]**.
- E. Configuration: Units shall be designed for flush burial and have **[open] [integral closed]** bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, "ELECTRIC."
- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes **12 inches wide by 24 inches long (300 mm wide by 600 mm long)** and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.10 PRECAST MANHOLES

- A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.
- B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. **Carder Concrete Products.**

2. Christy Concrete Products.
 3. Elmhurst-Chicago Stone Co.
 4. Oldcastle Precast, Inc.
 5. Riverton Concrete Products.
 6. Utility Concrete Products, LLC.
 7. Utility Vault Co.
 8. Wausau Tile, Inc.
 9. Smith-Midland.
- C. Comply with ASTM C 858.
- D. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.
- E. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional **12 inches (300 mm)** vertically and horizontally to accommodate alignment variations.
1. **[Splayed] [Center window]** location.
 2. Knockout panels shall be located no less than **6 inches (150 mm)** from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
 4. Knockout panel shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 5. Knockout panels shall be **1-1/2 to 2 inches (38 to 50 mm)** thick.
- F. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
1. Type and size shall match fittings to duct to be terminated.
 2. Fittings shall align with elevations of approaching duct and be located near interior corners of manholes to facilitate racking of cable.
- G. Ground Rod Sleeve: Provide a **3-inch (75-mm)** PVC sleeve in manhole floors **2 inches (50 mm)** from the wall adjacent to, but not underneath, the duct entering the structure.
- H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- 2.11 [CAST-IN-PLACE MANHOLES]**
- A. **Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for duct entrance and sleeve for ground rod.**
 - B. **Materials: Comply with ASTM C 858 and with Section 03 3000 "Cast-in-Place Concrete."**
 - C. **Structural Design Loading: As specified in "Underground Enclosure Application" Article.]**

2.12 UTILITY STRUCTURE ACCESSORIES

- A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.
- B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
 - 1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches (725 mm).
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
 - 2. Cover Legend: Cast in. Selected to suit system.
 - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
 - b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
 - 3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.
 - b. Seal joints watertight using preformed plastic or rubber complying with ASTM C 990. Install sealing material according to sealant manufacturers' written instructions.
- C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.
 - 1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.
- E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (31-mm-) diameter eye, rated 2500-lbf (11-kN) minimum tension.
- F. Pulling-in and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
 - 1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.
- G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (31 mm) minimum at base.

1. Tested Ultimate Pullout Strength: **12,000 lbf (53 kN)** minimum.
 - H. Ground Rod Sleeve: **3-inch (75-mm)** PVC sleeve in manhole floors **2 inches (50 mm)** from the wall adjacent to, but not underneath, the ducts routed from the facility.
 - I. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with **1/2-inch (13-mm)** bolt, **5300-lbf (24-kN)** rated pullout strength, and minimum **6800-lbf (30-kN)** rated shear strength.
 - J. Cable Rack Assembly: Steel, [**hot-rolled**] [**hot-dip**] galvanized, except insulators.
 1. Stanchions: T-section or channel; **2-1/4-inch (56-mm)** nominal size; punched with 14 holes on **1-1/2-inch (38-mm)** centers for cable-arm attachment.
 2. Arms: **1-1/2 inches (38 mm)** wide, lengths ranging from **3 inches (75 mm)** with **450-lb (204-kg)** minimum capacity to **18 inches (450 mm)** with **250-lb (114-kg)** minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
 - K. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
 1. Stanchions: Nominal **36 inches (900 mm)** high by **4 inches (100 mm)** wide, with minimum of nine holes for arm attachment.
 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from **3 inches (75 mm)** with **450-lb (204-kg)** minimum capacity to **20 inches (500 mm)** with **250-lb (114-kg)** minimum capacity. Top of arm shall be nominally **4 inches (100 mm)** wide, and arm shall have slots along full length for cable ties.
 - L. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as **35 deg F (2 deg C)**. Capable of withstanding temperature of **300 deg F (150 deg C)** without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
 - M. Fixed Manhole Ladders: Arranged for attachment to roof and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from [**nonconductive, structural-grade, fiberglass-reinforced resin**] [**hot-dip galvanized steel**].
 - N. Cover Hooks: Heavy duty, designed for lifts **60 lbf (270 N)** and greater. Two required.
- 2.13 SOURCE QUALITY CONTROL
- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
 - B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 1. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

2. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.
- C. **[Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 31 1000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 31 1000 "Site Clearing."]**

3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Electrical Cables More Than 600 V: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.
- B. Duct for Electrical Feeders 600 V and Less: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.
- C. Duct for Electrical Branch Circuits: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.
- D. Bored Underground Duct: Type EPEC-40-HDPE unless otherwise indicated.
- E. Underground Ducts Crossing **[Paved Paths] [Walks] [and] [Driveways] [Roadways] [and Railroads]**: Type EPC-40 PVC RNC, encased in reinforced concrete.
- F. Stub-ups: Concrete-encased GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, **[H-10] [H-20]** structural load rating.
 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: **[Precast concrete, AASHTO HB 17, H-20] [Polymer concrete, SCTE 77, Tier 15] [Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15] [Fiberglass-reinforced polyester resin, SCTE 77, Tier 15] [High-density plastic, SCTE 77, Tier 15]** structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: [**Precast concrete, AASHTO HB 17, H-10**] [**Polymer concrete units, SCTE 77, Tier 8**] [**Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8**] [**High-density plastic, SCTE 77, Tier 8**] structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: [**Fiberglass-reinforced polyester resin**] [**High-density plastic**], structurally tested according to SCTE 77 with **3000-lbf (13 345-N)** vertical loading.
5. Cover design load shall not exceed the design load of the handhole or box.

B. Manholes: [**Precast**] [**or**] [**cast-in-place**] concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 31 2000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area [**immediately after backfilling is completed**] [**or**] [**after construction vehicle traffic in immediate area is complete**].
- C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 32 9200 "Turf and Grasses" and Section 32 9300 "Plants."
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 01 7300 "Execution."

3.5 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct according to NEMA TCB 2, "NEMA Guidelines for the Selection and Installation of Underground Nonmetallic Raceway."
- C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of [**48 inches (1200 mm)**] [**12.5 feet (4 m)**] [**25 feet (7.5 m)**], both horizontally and vertically, at other locations unless otherwise indicated.

1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.
- E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.
- F. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately **10 inches (250 mm)** o.c. for **5-inch (125-mm)** duct, and vary proportionately for other duct sizes.
 1. Begin change from regular spacing to end-bell spacing **10 feet (3 m)** from the end bell, without reducing duct slope and without forming a trap in the line.
 2. Grout end bells into structure walls from both sides to provide watertight entrances.
- G. Building Wall Penetrations: Make a transition from underground duct to GRC at least **10 feet (3 m)** outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 26 0544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- H. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least **15-psig (1.03-MPa)** hydrostatic pressure.
- I. Pulling Cord: Install **200-lbf- (1000-N-)** test nylon cord in empty ducts.
- J. Concrete-Encased Ducts and Duct Bank:
 1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 31 2000 "Earth Moving" for pipes less than **6 inches (150 mm)** in nominal diameter.
 2. Width: Excavate trench **3 inches (75 mm)** wider than duct on each side.
 3. Depth: Install so top of duct envelope is at least **24 inches (600 mm)** below finished grade in areas not subject to deliberate traffic, and at least **30 inches (750 mm)** below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
 4. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 5. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per **20 feet (6 m)** of duct. Place spacers within **24 inches (600 mm)** of duct ends. Stagger spacers approximately **6 inches (150 mm)** between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 6. Minimum Space between Duct: **3 inches (75 mm)** between edge of duct and exterior envelope wall, **2 inches (50 mm)** between ducts for like services, and **4 inches (100 mm)** between power and communications ducts.
 7. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
 - a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with **3 inches (75 mm)** of concrete.

- b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of **60 inches (1500 mm)** from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum **4 inches (100 mm)** above finished floor and minimum **3 inches (75 mm)** from conduit side to edge of slab.
 8. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 9. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 10. Concrete Cover: Install a minimum of **3 inches (75 mm)** of concrete cover between edge of duct to exterior envelope wall, **2 inches (50 mm)** between duct of like services, and **4 inches (100 mm)** between power and communications ducts.
 11. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install **3/4-inch (15-mm)** reinforcing-rod dowels extending a minimum of **18 inches (450 mm)** into concrete on both sides of joint near corners of envelope.
 12. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 03 3000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.
- K. Direct-Buried Duct and Duct Bank:
1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 31 2000 "Earth Moving" for preparation of trench bottoms for pipes less than **6 inches (150 mm)** in nominal diameter.
 2. Width: Excavate trench **3 inches (75 mm)** wider than duct on each side.
 3. Depth: Install top of duct at least **36 inches (900 mm)** below finished grade unless otherwise indicated.
 4. Set elevation of bottom of duct bank below frost line.
 5. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per **20 feet (6 m)** of duct. Place spacers within **24 inches (600 mm)** of duct ends. Stagger spacers approximately **6 inches (150 mm)** between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 7. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.

- a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with **3 inches (75 mm)** of concrete.
 - b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of **60 inches (1500 mm)** from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum **4 inches (100 mm)** above finished floor and minimum **3 inches (75 mm)** from conduit side to edge of slab.
 - c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of **60 inches (1500 mm)** from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum **4 inches (100 mm)** above finished floor and no less than **3 inches (75 mm)** from conduit side to edge of slab.
8. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to **4 inches (100 mm)** over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 31 2000 "Earth Moving" for installation of backfill materials.
- a. Place minimum **3 inches (75 mm)** of sand as a bed for duct. Place sand to a minimum of **6 inches (150 mm)** above top level of duct.
 - b. Place minimum **6 inches (150 mm)** of engineered fill above concrete encasement of duct.
- L. Underground-Line Warning Tape: Bury nonconducting underground line specified in Section 26 0553 "Identification for Electrical Systems" no less than **12 inches (300 mm)** above all concrete-encased duct and duct banks and approximately **12 inches (300 mm)** below grade. Align tape parallel to and within **3 inches (75 mm)** of centerline of duct bank. Provide an additional warning tape for each **12-inch (300-mm)** increment of duct-bank width over a nominal **18 inches (450 mm)**. Space additional tapes **12 inches (300 mm)** apart, horizontally.
- 3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES
- A. [Cast-in-Place Manhole Installation:**
1. **Finish interior surfaces with a smooth-troweled finish.**
 2. **Knockouts for Future Duct Connections: Form and pour concrete knockout panels **1-1/2 to 2 inches (38 to 50 mm)** thick, arranged as indicated.**
 3. **Comply with requirements in Section 03 3000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.]**
- B. Precast Concrete Handhole and Manhole Installation:**
1. Comply with ASTM C 891 unless otherwise indicated.
 2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.

3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from **1-inch (25-mm)** sieve to **No. 4 (4.75-mm)** sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevations:
1. Manhole Roof: Install with rooftop at least **15 inches (375 mm)** below finished grade.
 2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames **1 inch (25 mm)** above finished grade.
 3. Install handholes with bottom below frost line, **<Insert depth of frost line below grade at Project site>** below grade.
 4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes **1 inch (25 mm)** above finished grade.
 5. Where indicated, cast handhole cover frame integrally with handhole structure.
- D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.
- E. Dampproofing: Apply dampproofing to exterior surfaces of manholes[**and handholes**] after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 07 1113 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated.
- G. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- H. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than **3-7/8 inches (97 mm)** for manholes and **2 inches (50 mm)** for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- 3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE
- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
 - B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from **1/2-inch (12.5-mm)** sieve to **No. 4 (4.75-mm)** sieve and compacted to same density as adjacent undisturbed earth.
 - C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes **1 inch (25 mm)** above finished grade.

- D. Install handholes and boxes with bottom below frost line, **<Insert depth of frost line below grade at Project site>** below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: **3000 psi (20 kPa)**, 28-day strength, complying with Section 03 3000 "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: **10 inches wide by 12 inches deep (250 mm wide by 300 mm deep)**.

3.8 GROUNDING

- A. Ground underground ducts and utility structures according to Section 26 0526 "Grounding and Bonding for Electrical Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
 - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum **12-inch- (300-mm-)** long mandrel equal to duct size minus **1/4 inch (6 mm)**. If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole[**and handhole**] grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 0526 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.
- C. Prepare test and inspection reports.

3.10 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump.

1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

END OF SECTION 26 0543

SECTION 26 0544

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
- 2. Sleeve-seal systems.
- 3. Sleeve-seal fittings.
- 4. Grout.
- 5. Silicone sealants.

- B. Related Requirements:

- 1. Section 07 8413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Sustainable Design Submittals:

- 1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
- 2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products 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."

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:

- 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; **0.0239-inch (0.6-mm)** minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. Sleeves for Rectangular Openings:
 1. Material: Galvanized sheet steel.
 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than **50 inches (1270 mm)** and with no side larger than **16 inches (400 mm)**, thickness shall be **0.052 inch (1.3 mm)**.
 - b. For sleeve cross-section rectangle perimeter **50 inches (1270 mm)** or more and one or more sides larger than **16 inches (400 mm)**, thickness shall be **0.138 inch (3.5 mm)**.

2.2 SLEEVE-SEAL SYSTEMS

- 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 Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 - f. Hilti.
 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: [**Carbon steel**] [**Stainless steel**].
 4. Connecting Bolts and Nuts: [**Carbon steel, with corrosion-resistant coating,**] [**Stainless steel**] of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Holdrite.

2.4 GROUT

- A. Description: Nonshrink; recommended 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 (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 - 2. Sealant shall have VOC content of <Insert value> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Sealant 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."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1, "Standard Practice for Good Workmanship in Electrical Construction."
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 9200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors **2 inches (50 mm)** above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using **[steel] [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.
- G. Underground, Exterior-Wall and Floor 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 sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install 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.

3.3 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.

END OF SECTION 26 0544

SECTION 26 0553

IDENTIFICATION FOR ELECTRICAL 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. Color and legend requirements for raceways, conductors, and warning labels and signs.
- 2. Labels.
- 3. Bands and tubes.
- 4. Tapes and stencils.
- 5. Tags.
- 6. Signs.
- 7. Cable ties.
- 8. Paint for identification.
- 9. Fasteners for labels and signs.

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 electrical identification products.

- B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

- C. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1[**and IEEE C2**].
- B. Comply with NFPA 70, "National Electrical Code."
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.

- E. Comply with [NFPA 70E] [and] [Section 26 0574 "Overcurrent Protective Device Arc-Flash Study"] requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F (49 deg C), ambient; 180 deg F (82 deg C), material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Colors for 240-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - 4. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - 5. Color for Neutral: White or gray.
 - 6. Color for Equipment Grounds: Green.
 - 7. Colors for Isolated Grounds: Green with white stripe.

- C. Raceways and Cables Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
- D. Warning Label Colors:
 - 1. Identify system voltage with black letters on an orange background.
- E. Warning labels and signs shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
- F. Equipment Identification Labels:
 - 1. Black letters on a white field.
 - 2. **<Insert specific requirements for equipment to be labeled, such as transformers, panelboards, etc.>**

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- (0.08-mm-) thick, polyester flexible label with acrylic pressure-sensitive adhesive.
 - 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 - 2. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3-mil- (0.08-mm-) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches (37 by 150 mm) for raceway and conductors.
 - b. 3-1/2 by 5 inches (76 by 127 mm) for equipment.
 - c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

- A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, **2 inches (50 mm)** long, with diameters sized to suit diameters and that stay in place by gripping action.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of **200 deg F (93 deg C)**. Comply with UL 224.

2.5 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than **3 mils (0.08 mm)** thick by **1 to 2 inches (25 to 50 mm)** wide; compounded for outdoor use.
- C. Tape and Stencil: **4-inch- (100-mm-)** wide black stripes on **10-inch (250-mm)** centers placed diagonally over orange background and is **12 inches (300 mm)** wide. Stop stripes at legends.
- D. Floor Marking Tape: **2-inch- (50-mm-)** wide, **5-mil (0.125-mm)** pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
- E. Underground-Line Warning Tape:
 - 1. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 - 2. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
 - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
 - 3. Tag: **[Type I] <Insert drawing designation>**:
 - a. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: **3 inches (75 mm)**.
 - c. Thickness: **4 mils (0.1 mm)**.
 - d. Weight: **18.5 lb/1000 sq. ft. (9.0 kg/100 sq. m)**.
 - e. Tensile according to ASTM D 882: **30 lbf (133.4 N)** and **2500 psi (17.2 MPa)**.

4. Tag: **[Type II]** <Insert drawing designation>:
- a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: **3 inches** (75 mm).
 - c. Thickness: **12 mils** (0.3 mm).
 - d. Weight: **36.1 lb/1000 sq. ft.** (17.6 kg/100 sq. m).
 - e. Tensile according to ASTM D 882: **400 lbf** (1780 N) and **11,500 psi** (79.2 MPa).
5. Tag: **[Type ID]** <Insert drawing designation>:
- a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, **[continuous-printed on one side with the inscription of the utility,]** compounded for direct-burial service.
 - b. Width: **3 inches** (75 mm).
 - c. Overall Thickness: **5 mils** (0.125 mm).
 - d. Foil Core Thickness: **0.35 mil** (0.00889 mm).
 - e. Weight: **28 lb/1000 sq. ft.** (13.7 kg/100 sq. m).
 - f. Tensile according to ASTM D 882: **70 lbf** (311.3 N) and **4600 psi** (31.7 MPa).
6. Tag: **[Type IID]** <Insert drawing designation>:
- a. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, **[continuous-printed on one side with the inscription of the utility,]** compounded for direct-burial service.
 - b. Width: **3 inches** (75 mm).
 - c. Overall Thickness: **8 mils** (0.2 mm).
 - d. Foil Core Thickness: **0.35 mil** (0.00889 mm).
 - e. Weight: **34 lb/1000 sq. ft.** (16.6 kg/100 sq. m).
 - f. Tensile according to ASTM D 882: **300 lbf** (1334 N) and **12,500 psi** (86.1 MPa).
- F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be **1 inch** (25 mm).

2.6 TAGS

- A. Metal Tags: Brass or aluminum, **2 by 2 by 0.05 inch** (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- B. Nonmetallic Preprinted Tags: Polyethylene tags, **0.015 inch** (0.38 mm) thick, color-coded for phase and voltage level, with factory screened permanent designations; punched for use with self-locking cable tie fastener.
- C. Write-on Tags:
- 1. Polyester Tags: **0.010 inch** (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 SIGNS

A. Baked-Enamel Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. **1/4-inch (6.4-mm)** grommets in corners for mounting.
3. Nominal Size: **7 by 10 inches (180 by 250 mm)**.

B. Metal-Backed Butyrate Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with **0.0396-inch (1-mm)** galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
2. **1/4-inch (6.4-mm)** grommets in corners for mounting.
3. Nominal Size: **10 by 14 inches (250 by 360 mm)**.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:
 - a. For signs up to **20 sq. in. (129 sq. cm)**, minimum **1/16 inch (1.6 mm)** thick).
 - b. For signs larger than **20 sq. in. (129 sq. cm)**, **1/8 inch (3.2 mm)** thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with **1/4-inch (6.4-mm)** grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: **3/16 inch (5 mm)**.
2. Tensile Strength at **73 Deg F (23 Deg C)** according to ASTM D 638: **12,000 psi (82.7 MPa)**.
3. Temperature Range: **Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**.
4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: **3/16 inch (5 mm)**.
2. Tensile Strength at **73 Deg F (23 Deg C)** according to ASTM D 638: **12,000 psi (82.7 MPa)**.
3. Temperature Range: **Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: **3/16 inch (5 mm)**.
2. Tensile Strength at **73 Deg F (23 Deg C)** according to ASTM D 638: **7000 psi (48.2 MPa)**.
3. UL 94 Flame Rating: **94V-0**.
4. Temperature Range: **Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C)**.
5. Color: **Black**.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 1. Secure tight to surface of conductor, cable, or raceway.
- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum **3/8-inch- (10-mm-)** high letters for emergency instructions at equipment used for **[power transfer] [load shedding] <Insert emergency operations>**.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
 1. "EMERGENCY POWER."
 2. "POWER."
 3. "UPS."
- M. Vinyl Wraparound Labels:
 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- P. Self-Adhesive Labels:
 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 2. Unless otherwise indicated, provide a single line of text with **1/2-inch- (13-mm-)** high letters on **1-1/2-inch- (38-mm-)** high label; where two lines of text are required, use labels **2 inches (50 mm)** high.
- Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of **6 inches (150 mm)** where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

- T. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- U. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- V. Underground Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at **12 inches (305 mm)** below finished grade. Use multiple tapes where width of multiple lines installed in a common trench [**or concrete envelope**] exceeds **16 inches (400 mm)** overall.
 2. Install underground-line warning tape for direct-buried cables and cables in raceways.
- W. Metal Tags:
1. Place in a location with high visibility and accessibility.
 2. Secure using [**general-purpose**] [**UV-stabilized**] [**plenum-rated**] cable ties.
- X. Nonmetallic Preprinted Tags:
1. Place in a location with high visibility and accessibility.
 2. Secure using [**general-purpose**] [**UV-stabilized**] [**plenum-rated**] cable ties.
- Y. Write-on Tags:
1. Place in a location with high visibility and accessibility.
 2. Secure using [**general-purpose**] [**UV-stabilized**] [**plenum-rated**] cable ties.
- Z. Baked-Enamel Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 2. Unless otherwise indicated, provide a single line of text with **1/2-inch- (13-mm-)** high letters on minimum **1-1/2-inch- (38-mm-)** high sign; where two lines of text are required, use signs minimum **2 inches (50 mm)** high.
- AA. Metal-Backed Butyrate Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 2. Unless otherwise indicated, provide a single line of text with **1/2-inch- (13-mm-)** high letters on **1-1/2-inch- (38-mm-)** high sign; where two lines of text are required, use labels **2 inches (50 mm)** high.
- BB. Laminated Acrylic or Melamine Plastic Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 2. Unless otherwise indicated, provide a single line of text with **1/2-inch- (13-mm-)** high letters on **1-1/2-inch- (38-mm-)** high sign; where two lines of text are required, use labels **2 inches (50 mm)** high.

CC. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch- (75-mm-) high, black letters on 20-inch (500-mm) centers.
1. Locate identification at changes in direction, at penetrations of walls and floors, and at 30-foot (10-m) maximum intervals.
- D. Accessible Raceways and Metal-Clad Cables, More Than 600 V: Snap-around labels.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- E. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- F. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
1. "EMERGENCY POWER."
 2. "POWER."
 3. "UPS."
- G. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- H. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.

- I. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use write-on tags with the conductor or cable designation, origin, and destination.
- J. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.
- K. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- L. Auxiliary Electrical Systems Conductor Identification: Marker tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- M. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- N. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:
 - 1. Floor surface directly above conduits running beneath and within **12 inches (300 mm)** of a floor that is in contact with earth or is framed above unexcavated space.
 - 2. Wall surfaces directly external to raceways concealed within wall.
 - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- O. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- P. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- Q. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.
 - 1. Apply to exterior of door, cover, or other access.
 - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.
- R. Arc Flash Warning Labeling: Self-adhesive labels.
- S. Operating Instruction Signs: Baked-enamel warning signs.
- T. Emergency Operating Instruction Signs: Baked-enamel warning signs with white legend on a red background with minimum **3/8-inch- (10-mm-)** high letters for emergency instructions at equipment used for **[power transfer] [load shedding] <Insert emergency operations>**.

U. Equipment Identification Labels:

1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
2. Outdoor Equipment: Laminated acrylic or melamine sign.
3. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchgear.
 - e. Switchboards.
 - f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - g. Substations.
 - h. Emergency system boxes and enclosures.
 - i. Motor-control centers.
 - j. Enclosed switches.
 - k. Enclosed circuit breakers.
 - l. Enclosed controllers.
 - m. Variable-speed controllers.
 - n. Push-button stations.
 - o. Power-transfer equipment.
 - p. Contactors.
 - q. Remote-controlled switches, dimmer modules, and control devices.
 - r. Battery-inverter units.
 - s. Battery racks.
 - t. Power-generating units.
 - u. Monitoring and control equipment.
 - v. UPS equipment.
 - w. **<Insert equipment>**.

END OF SECTION 26 0553

SECTION 26 0573.13
SHORT-CIRCUIT STUDIES

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]** **[may]** 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.
 - 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.
 - b. 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 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.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

- A. Software Developers: Subject to compliance with requirements, provide software by one of the following:
 - 1. [ESA Inc.](#)
 - 2. [Operation Technology, Inc.](#)
 - 3. [Power Analytics, Corporation.](#)
 - 4. SKM System Analysis, Inc.
- B. Comply with IEEE 399 and IEEE 551.
- C. 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.
- D. 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 "3.1 EXAMINATION."
- 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.
- 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. 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.
- H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:
1. Electric utility's supply termination point.
 2. Incoming switchgear.
 3. Unit substation primary and secondary terminals.
 4. Low-voltage switchgear.
 5. Motor-control centers.
 6. Control panels.
 7. Standby generators and automatic transfer switches.
 8. Branch circuit panelboards.
 9. Disconnect switches.

3.3 ADJUSTING

- A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

END OF SECTION 26 0573.13

SECTION 26 0573.16
COORDINATION STUDIES

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.

1.3 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]** **[may]** 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 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.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. **Software Developers:** Subject to compliance with requirements, provide software by one of the following:

1. **ESA Inc.**
 2. **Operation Technology, Inc.**
 3. **Power Analytics, Corporation.**
 4. **SKM Systems Analysis, Inc.**
- 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.

2.2 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 260573.16 " Short-Circuit Studies."
- 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. Provide adequate time margins between device characteristics such that selective operation is achieved.
 6. 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. Unit substation primary and secondary terminals.
 - 4. Low-voltage switchgear.
 - 5. Motor-control centers.
 - 6. Standby generators and automatic transfer switches.
 - 7. 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.

3.3 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 **<Insert applicable standards>**, 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**] coordination studies.
 - 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.

END OF SECTION 26 0573.16

SECTION 26 0573.19

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. 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. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals **[shall]** **[may]** 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 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 Arc-Flash Study Specialist.
- 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. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
 - 2. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

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. Arc-Flash 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 licenses professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the 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.
- D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capacity of 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 28 CFR 1910.7, and is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Software Developers: Subject to compliance with requirements, provide software by one of the following:
 - 1. ESA Inc.
 - 2. Operation Technology, Inc.

3. [Power Analytics, Corporation.](#)
4. [SKM Systems Analysis, Inc.](#)

- B. Comply with IEEE 1584 and NFPA 70E.
- 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.

2.2 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope.
- 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 260573.13 " Short-Circuit Studies."
- F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573.16 " Coordination Studies."
- G. Arc-Flash Study Output:
 1. 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.
- H. 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. Working distance.

6. Incident energy.
7. Hazard risk category.
8. Recommendations for arc-flash energy reduction.

- I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a **3.5-by-5-inch (76-by-127-mm)** thermal transfer label of high-adhesion polyester for each work location included in the analysis.
- B. The 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. Flash protection boundary.
 4. Hazard risk category.
 5. Incident energy.
 6. Working distance.
 7. Engineering report number, revision number, and issue date.
- C. 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:
 1. 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."
 2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."
- C. Calculate maximum and minimum contributions of fault-current size.
 1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.

2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 125 kVA.
- F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.
- G. 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 should not be considered beyond three to five cycles.
 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
- H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
 1. When the circuit breaker is in a separate enclosure.
 2. When the line terminals of the circuit breaker are separate from the work location.
- I. 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 the conduct of the arc-flash hazard analysis.
 1. Verify completeness of data supplied on the one-line diagram on Drawings[**and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article**]. 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.
- 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 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. Obtain 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 per cent, 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, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

3.4 LABELING

- A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:
 1. Motor-control center.
 2. Low-voltage switchboard.
 3. Switchgear.
 4. Medium-voltage switch.
 5. Control panel.

3.5 APPLICATION OF WARNING LABELS

- A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.6 DEMONSTRATION

- A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 26 0573.19

SECTION 26 0923

LIGHTING CONTROL DEVICES

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. Time switches.
2. Photoelectric switches.
3. Standalone daylight-harvesting switching and dimming controls.
4. Indoor occupancy and vacancy sensors.
5. Switchbox-mounted occupancy sensors.
6. Digital timer light switches.
7. High-bay occupancy sensors.
8. Extreme temperature occupancy sensors.
9. Outdoor motion sensors.
10. Lighting contactors.
11. Emergency shunt relays.

- B. Related Requirements:

1. Section 26 2726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings:

1. Show installation details for the following:
 - a. Occupancy sensors.
 - b. Vacancy sensors.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

- B. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: **[On USB media] [On manufacturer's website]**. Provide names, versions, and website addresses for locations of installed software.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control software.
 - b. Faulty operation of lighting control devices.
 - 2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

- A. **Manufacturers:** Subject to compliance with requirements, provide products by the following:
 - 1. **Leviton Manufacturing Co., Inc.**
 - 2. **NSi Industries LLC.**
 - 3. **Tyco Electronics Corporation; a TE Connectivity Ltd. company.**
 - 4. **Tork Products.**
 - 5. **Watt Stopper.**
 - 6. **Intermatic, Inc.**
 - 7. **Invensys Controls.**
- B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
 - 1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
 - 2. Contact Configuration: **[SPST] [DPST] [DPDT]**.
 - 3. Contact Rating: **[30-A inductive or resistive, 240-V ac] [20-A ballast load, 120-/240-V ac]**.
 - 4. Programs: Eight on-off set points on a 24-hour schedule **[and an annual holiday schedule that overrides the weekly operation on holidays]**.
 - 5. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week **[and an annual holiday schedule that overrides the weekly operation on holidays]**.

6. Programs: **<Insert number>** channels; each channel is individually programmable with eight on-off set points on a 24-hour schedule.
7. Programs: **<Insert number>** channels; each channel is individually programmable with two on-off set points on a 24-hour schedule with a skip-a-day weekly schedule.
8. Programs: **<Insert number>** channels; each channel is individually programmable with two on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
9. Programs: **<Insert number>** channels; each channel is individually programmable with 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.
10. Programs: **<Insert number>** channels; each channel is individually programmable with 40 on-off operations per week, plus four seasonal schedules that modify the basic program and an annual holiday schedule that overrides the weekly operation on holidays.
11. Programs: **<Insert configuration>**[**and an annual holiday schedule that overrides the weekly operation on holidays**].
12. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program[**on selected channels**].
13. Astronomic Time: [**All**] [**Selected**] channels.
14. Automatic daylight savings time changeover.
15. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

C. Electromechanical-Dial Time Switches: Comply with UL 917.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Contact Configuration: [**SPST**] [**DPST**] [**SPDT**] [**DPDT**].
3. Contact Rating: [**30-A inductive or resistive, 240-V ac**] [**20-A ballast load, 120-/240-V ac**].
4. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
5. Astronomic time dial.
6. Eight-Day Program: Uniquely programmable for each weekday and holidays.
7. Skip-a-day mode.
8. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. **Cooper Industries, Inc.**
2. **Intermatic, Inc.**
3. **NSi Industries LLC.**
4. **Tyco Electronics Corporation; a TE Connectivity Ltd. company.**
5. **Lithonia Lighting; Acuity Lighting Group.**

B. Description: Solid state, with [**SPST**] [**DPST**] dry contacts rated for [**1000 W incandescent**] [**or**] [**1800 VA inductive**], to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Light-Level Monitoring Range: **1.5 to 10 fc (16.14 to 108 lux)**, with an adjustment for turn-on and turn-off levels within that range[, **and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off**].
 3. Time Delay: Fifteen-second minimum, to prevent false operation.
 4. Surge Protection: Metal-oxide varistor.
 5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
 6. Failure Mode: Luminaire stays ON.
- C. Description: Solid state, with **[SPST] [DPST]** dry contacts rated for **[1000 W incandescent] [or] [1800 VA inductive]**, to operate connected load, complying with UL 773, and compatible with CFL and LED lamps.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: **1.5 to 10 fc (16.14 to 108 lux)**, with an adjustment for turn-on and turn-off levels within that range.
 3. Time Delay: Thirty-second minimum, to prevent false operation.
 4. Lightning Arrester: Air-gap type.
 5. Mounting: Twist lock complying with NEMA C136.10, with base.
 6. Failure Mode: Luminaire stays ON.
- D. Description: Solid state; one set of NO dry contacts rated for **[24 V dc at 1 A] [24 V ac at 1 A]**, to operate connected load, complying with UL 773, and compatible with **[luminaire] [power pack] [lighting control panelboard]**.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: **1.5 to 10 fc (16.14 to 108 lux)**, with an adjustment for turn-on and turn-off levels within that range.
 3. Time Delay: Thirty-second minimum, to prevent false operation.
 4. Mounting: **1/2-inch (13-mm)** threaded male conduit.
 5. Failure Mode: Luminaire stays ON.
 6. Power Pack: Dry contacts rated for 16A ballast or LED load at 120- and 277-V ac, for **[13-A] <Insert value>** tungsten at 120-V ac, and for **[1 hp] <Insert value>** at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - a. LED status lights to indicate load status.
 - b. Plenum rated.
 7. Power Pack: Digital controller capable of accepting **[three] [four] <Insert number>** RJ45 inputs with **[one] [two]** outputs rated for **[20-A] <Insert value>** incandescent[**or LED**] load at 120- and 277-V ac, for **[13-A] [16-A] <Insert value>** [ballast] [**or**] **[LED]** at 120- and 277-V ac, and for **[1 hp] <Insert value>** at 120-V ac. Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
 - a. With integral current monitoring
 - b. Compatible with digital addressable lighting interface.
 - c. Plenum rated.

2.3 DAYLIGHT-HARVESTING SWITCHING CONTROLS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
 2. Eaton Corporation.
 3. Hubbell Building Automation, Inc.
 4. Leviton Manufacturing Co., Inc.
 5. Lithonia Lighting; Acuity Brands Lighting, Inc.
 6. NSi Industries LLC.
 7. Sensor Switch, Inc.
 8. Tyco Electronics Corporation; a TE Connectivity Ltd. company.
 9. Watt Stopper.
- B. System Description: System operates indoor lighting.
- C. Sequence of Operation: As daylight increases, the lights are turned off at a predetermined level. As daylight decreases, the lights are turned on at a predetermined level.
1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present.
 - b. When significant daylight is present (target level).
 - c. System programming is done with two hand-held, remote-control tools.
- D. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with **[integrated]** power pack, that detects changes in indoor lighting levels that are perceived by the eye.
- E. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack **[mounted on luminaire]**, that detects changes in indoor lighting levels that are perceived by the eye.
- F. Electrical Components, Devices, and Accessories:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operating Ambient Conditions: Dry interior conditions, **32 to 120 deg F (0 to 49 deg C)**.
 3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor shall be powered by the power pack.
 4. Sensor Output: Digital signal compatible with power pack.
 5. Sensor type: **[Open loop] [Closed loop]**.
 6. Zone: **[Single] [Multi]**.
 7. Power Pack: Dry contacts rated for 16A ballast or LED load at 120- and 277-V ac, for **[13-A] <Insert value>** tungsten at 120-V ac, and for **[1 hp] <Insert value>** at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - a. LED status lights to indicate load status.
 - b. Plenum rated.
 8. Power Pack: Digital controller capable of accepting **[3] [4] <Insert number>** RJ45 inputs with **[one] [two]** outputs rated for **[20-A] <Insert value>** incandescent **[or] [LED]** load at 120- and 277-V ac, for **[13-A] [16-A] <Insert value>** **[ballast] [or LED]** at 120- and 277-

V ac, and for [1 hp] <Insert value> at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.

- a. With integral current monitoring
 - b. Compatible with digital addressable lighting interface.
 - c. Plenum rated.
9. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lux), with an adjustment for turn-on and turn-off levels within that range.
 10. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc (1080 to 10 800 lux), with an adjustment for turn-on and turn-off levels within that range.
 11. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lux), with an adjustment for turn-on and turn-off levels within that range.
 12. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
 13. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
 14. Test Mode: User selectable, overriding programmed time delay to allow settings check.
 15. Control Load Status: User selectable to confirm that load wiring is correct.
 16. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Industries, Inc.
 2. Hubbell Building Automation, Inc.
 3. Leviton Manufacturing Co., Inc.
 4. Lithonia Lighting; Acuity Brands Lighting, Inc.
 5. Watt Stopper.
- B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
 1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with **[integrated]** **[separate]** power pack **[mounted on luminaire]**, to detect changes in indoor lighting levels that are perceived by the eye.
- D. Electrical Components, Devices, and Accessories:
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
 3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).
- E. Power Pack: Dry contacts rated for 16A ballast or LED load at 120- and 277-V ac, for [13-A] <Insert value> tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
1. LED status lights to indicate load status.
 2. Plenum rated.
- F. Power Pack: Digital controller capable of accepting [3] [4] <Insert number> RJ45 inputs with [one] [two] outputs rated for [20-A] <Insert value> incandescent [or] [LED] load at 120- and 277-V ac, for [13-A] [16-A] <Insert value> [ballast load] [or] [LED] at 120- and 277-V ac, and for [1 hp] <Insert value> at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.
1. With integral current monitoring
 - a. Compatible with digital addressable lighting interface.
 - 1) Plenum rated.

2.5 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
 2. Hubbell Building Automation, Inc.
 3. Leviton Manufacturing Co., Inc.
 4. Lightolier Controls.
 5. Lithonia Lighting; Acuity Brands Lighting, Inc.
 6. Lutron Electronics Co., Inc.
 7. NSi Industries LLC; Tork Products.
 8. Square D.
 9. Watt Stopper.
- B. General Requirements for Sensors:
1. [Wall] [Ceiling]-mounted, solid-state indoor [occupancy] [and] [vacancy] sensors.
 2. [Passive infrared] [Ultrasonic] [Dual] technology.
 3. [Integrated] [Separate] power pack.
 4. [Hardwired] [Wireless] connection to switch[and BAS] [; and BAS and lighting control system].
 5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 6. Operation:
 - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

- c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
7. Sensor Output: **[Contacts rated to operate the connected relay, complying with UL 773A] [Sensor is powered from the power pack] [Wireless]**.
 8. Power: **[Line voltage] [Integral photovoltaic collector]**.
 9. Power Pack: Dry contacts rated for 16A ballast or LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 10. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a **1/2-inch (13-mm)** knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 12. Bypass Switch: Override the "on" function in case of sensor failure.
 13. Automatic Light-Level Sensor: Adjustable from **2 to 200 fc (21.5 to 2152 lux)**; turn lights off when selected lighting level is present.
- C. PIR Type: **[Wall] [Ceiling]** mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of **6-inch- (150-mm-)** minimum movement of any portion of a human body that presents a target of not less than **36 sq. in. (232 sq. cm)**.
 2. Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of **1000 sq. ft. (93 sq. m)** when mounted on a **96-inch- (2440-mm-)** high ceiling.
 3. Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within **90 feet (27.4 m)** when mounted on a **10-foot- (3-m-)** high ceiling.
 4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of **1000 square feet (110 square meters)** **[2000 square feet (220 square meters)] [3000 square feet (330 square meters)]** when mounted **48 inches (1200 mm)** above finished floor.
- D. Ultrasonic Type: **[Wall] [Ceiling]** mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than **12 inches (305 mm)** in either a horizontal or a vertical manner at an approximate speed of **12 inches/s (305 mm/s)**.
 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of **600 sq. ft. (56 sq. m)** when mounted on a **96-inch- (2440-mm-)** high ceiling.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of **1000 sq. ft. (93 sq. m)** when mounted on a **96-inch- (2440-mm-)** high ceiling.
 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of **2000 sq. ft. (186 sq. m)** when mounted on a **96-inch- (2440-mm-)** high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within **90 feet (27.4 m)** when mounted on a **10-foot- (3-m-)** high ceiling in a corridor not wider than **14 feet (4.3 m)**.

6. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [1000 square feet (110 square meters)] [2000 square feet (220 square meters)] [3000 square feet (330 square meters)] when mounted 84 inches (2100 mm) above finished floor.
- E. Dual-Technology Type: [Wall] [Ceiling] mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [1000 square feet (110 square meters)] [2000 square feet (220 square meters)] [3000 square feet (330 square meters)] when mounted 48 inches (1200 mm) above finished floor.

2.6 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. Bryant Electric.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Manufacturing Co., Inc.
 5. Lithonia Lighting; Acuity Brands Lighting, Inc.
 6. Lutron Electronics Co., Inc.
 7. NSi Industries LLC.
 8. Sensor Switch, Inc.
 9. Square D.
 10. Lightolier Controls.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox[, **with provisions for connection to BAS**] [using hardwired connection] [using wireless connection].
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
 4. Switch Rating: Not less than 800-VA [ballast] [or] [LED] load at 120 V, 1200-VA [ballast] [or] [LED] load at 277 V, and 800-W incandescent.
- C. Wall-Switch Sensor Tag WS1:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of [900 sq. ft. (84 sq. m)] [2100 sq. ft (196 sq. m)].
2. Sensing Technology: [PIR] [Dual technology - PIR and ultrasonic].
3. Switch Type: [SP.] [SP, dual circuit.] [SP, manual "on," automatic "off."] [SP, field-selectable automatic "on," or manual "on," automatic "off."]
4. Capable of controlling load in three-way application.
5. Voltage: [Match the circuit voltage] [120 V] [277 V] [Dual voltage - 120 and 277 V].
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
8. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
10. Color: [White] [Black] <Insert color>.
11. Faceplate: Color matched to switch.

D. Wall-Switch Sensor Tag WS2:

1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
2. Sensing Technology: PIR.
3. Switch Type: [SP.] [SP, dual circuit.] [SP, manual "on," automatic "off."] [SP, field-selectable automatic "on," or manual "on," automatic "off."]
4. Capable of controlling load in three-way application.
5. Voltage: [Match the circuit voltage] [120 V] [277 V] [Dual voltage, 120 and 277 V].
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
8. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
10. Color: [White] [Black] <Insert color>.
11. Faceplate: Color matched to switch.

2.7 DIGITAL TIMER LIGHT SWITCH

A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Invensys Controls.
4. Leviton Manufacturing Co., Inc.
5. NSi Industries LLC.
6. Tyco Electronics Corporation.

B. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in [10] [20] minute increments.

1. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 amps at 277-V ac for [ballast] [or] [LED], and 1/4 horsepower at 120-V ac.
2. Integral relay for connection to BAS.

3. Voltage: **[Match the circuit voltage] [120 V] [277 V] [Dual voltage - 120 and 277 V]**.
4. Color: **[White] [Black] <Insert color>**.
5. Faceplate: Color matched to switch.

2.8 HIGH-BAY OCCUPANCY SENSORS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by the following:

1. Hubbell Building Automation, Inc.

- B. General Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
4. Power: Line voltage.
5. Operating Ambient Conditions: **32 to 149 deg F (0 to 65 deg C)**.
6. Mounting: Threaded pipe.
7. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
8. Detector Technology: PIR.
9. Power and dimming control from the luminaire ballast that has been modified to include the dimming capacitor[**and MyzerPORT option**].

- C. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from **12 to 50 feet (3.7 to 15.2 m)**.

- D. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.9 EXTREME-TEMPERATURE OCCUPANCY SENSORS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. **Cooper Industries, Inc.**
2. Senso Switch, Inc.

- B. Description: Ceiling-mounted, solid-state, extreme-temperature occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended application in damp locations.
2. Operation: Turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
3. Operating Ambient Conditions: From **minus 40 to plus 125 deg F (minus 40 to plus 52 deg C)**.

4. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 5. Power Pack: Dry contacts rated for 20-A [ballast] [or] [LED] load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 6. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind cover.
 7. Bypass Switch: Override the "on" function in case of sensor failure.
 8. Automatic Light-Level Sensor: Adjustable from 2 to 10 fc (21.5 to 108 lux); keep lighting off when selected lighting level is present.
- C. Detector Technology: PIR. Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1500 sq. ft. (139 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 3. Detection Coverage (High Bay): Detect occupancy within 25 feet (7.6 m) when mounted on a 25-foot- (7.6-m-) high ceiling.

2.10 OUTDOOR MOTION SENSORS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. Bryant Electric.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Manufacturing Co., Inc.
 5. Lithonia Lighting; Acuity Brands Lighting, Inc.
 6. NSi Industries LLC.
 7. Sensor Switch, Inc.
 8. Watt Stopper.
- B. General Requirements for Sensors: Solid-state outdoor motion sensors.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application[, **and shall comply with California Title 24**].
 2. **[PIR] [Dual-technology (PIR and infrared)]** type, weatherproof. Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm). Comply with UL 773A.
 3. Switch Rating:
 - a. Luminaire-Mounted Sensor: **[1000-W incandescent, 500-VA fluorescent/LED] <Insert rating>**.
 - b. Separately Mounted Sensor: Dry contacts rated for 20-A [ballast] [or] [LED] load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

4. Switch Type: **[SP.] [SP, dual circuit.] [SP, manual "on," automatic "off.]" [SP, field-selectable automatic "on," or manual "on," automatic "off.]"**[With bypass switch to override the "on" function in case of sensor failure.]
5. Voltage: **[Match the circuit voltage] [120-V] [277-V] [Dual voltage, 120- and 277-V]** type.
6. Detector Coverage:
 - a. Standard Range: 210-degree field of view, with a minimum coverage area of **900 sq. ft. (84 sq. m)**.
 - b. Long Range: 180-degree field of view and **110-foot (34-m)** detection range.
7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from **10 to 150 fc (108 to 1600 lux)**. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
9. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
10. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.
11. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from **minus 40 to plus 130 deg F (minus 40 to plus 54 deg C)**, rated as "raintight" according to UL 773A.

2.11 LIGHTING CONTACTORS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 1. **ASCO Power Technologies, LP; a business of Emerson Network Power.**
 2. **Eaton Corporation.**
 3. **General Electric Company.**
 4. **Square D.**
- B. Description: Electrically operated and **[mechanically] [electrically]** held, combination-type lighting contactors with **[fusible switch] [nonfused disconnect]**, complying with NEMA ICS 2 and UL 508.
 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.
 4. Provide with control and pilot devices as **[indicated on Drawings] [scheduled]**, matching the NEMA type specified for the enclosure.
- C. Interface with DDC System for HVAC: Provide hardware interface to enable the DDC system for HVAC to monitor and control lighting contactors.
 1. Monitoring: On-off status, **<Insert monitoring point>**.
 2. Control: On-off operation, **<Insert control point>**.

2.12 EMERGENCY SHUNT RELAY

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. **Lighting Control and Design.**
 2. **Watt Stopper.**
 3. Entertainment Networks.
 4. Iota Engineering.
 5. Philips Bodine.
 6. LVS, Inc.
- B. Description: NC, electrically held relay, arranged for wiring in parallel with manual [**or automatic**] switching contacts; complying with UL 924.
1. Coil Rating: [**120**] [**277**] V.

2.13 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

- A. Comply with NECA 1, "Standard Practice for Good Workmanship in Electrical Construction."
- B. 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 systems, and partition assemblies.

- C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

- A. Comply with NECA 1.
- B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Comply with Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is **3/4 inch (19 mm)**.
- C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 26 0553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in [**Section 26 0943.16 "Addressable-Luminaire Lighting Controls"]**[and **Section 26 0943.23 "Relay-Based Lighting Controls."**]
- B. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 0923

SECTION 26 1116.12

SECONDARY UNIT SUBSTATIONS WITH SWITCHBOARDS SECONDARY

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 secondary unit substations, each consisting of medium-voltage primary incoming section, transformer section, and low-voltage secondary switchboard section, with the following features:
 - 1. Indoor enclosure.
 - 2. Medium-voltage, metal-enclosed switchgear section.
 - 3. Dry-type transformer.
- B. Related Requirements:
 - 1. Section 26 0513 "Medium-Voltage Cables" for requirements for terminating cables in incoming section of substation.

1.3 DEFINITIONS

- A. BIL: Basic insulation level.
- B. ICCB: Insulated-case circuit breaker.
- C. MCCB: Molded-case circuit breaker.
- D. NETA ATS: Acceptance testing specification.
- E. PCB: Polychlorinated biphenyl.
- F. SPD: Surge protective device.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Dimensioned plans and elevations showing major components and features.
 - a. Include a plan view and cross section of equipment base, showing clearances, manufacturer's recommended workspace that accounts for breaker service and removal, and locations of penetrations for grounding and conduits.
3. One-line diagram.
4. List of materials.
5. Nameplate legends.
6. The material, size and number of bus bars, and current rating for each bus, including mains and branches of phase, neutral, and ground buses.
7. Short-time and short-circuit current ratings of secondary unit substations and components.
8. Ratings of individual protective devices.

C. Design Data:

1. Time-Current Characteristic Curves: For overcurrent protective devices.
2. Primary Fuses: Submit recommendations and size calculations.
3. Utility company's metering provisions with indication of approval by utility company.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings.

1. Indoor Installations:
 - a. Location plan, showing heavy equipment or truck access paths for maintenance and replacement.
 - b. Dimensioned concrete base, outline of secondary unit substation, conduit entries, and grounding equipment locations.
 - c. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways.
 - d. Location of lighting fixtures, sprinkler piping and heads, ducts, and diffusers.

B. Qualification Data: For testing agency.

C. Product Certificates: For secondary unit substations, signed by product manufacturer.

D. Factory test reports.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For secondary unit substations and accessories to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate delivery of secondary unit substations to allow movement into designated space.
- B. Store secondary unit substation components so condensation will not form on or in units. Provide temporary heating per manufacturer's written instructions.
- C. Handle secondary unit substation components per manufacturer's written instructions. Use factory-installed lifting provisions.

1.9 FIELD CONDITIONS

- A. Service Conditions: The unit substation shall be suitable for operation under service conditions specified as usual service conditions in IEEE C37.121, except for the following:
 1. Exposure to fumes, vapors, or dust.
 2. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
 3. Exposure to excessively high or low temperatures.
 4. Unusual transportation or storage conditions.
 5. Unusual grounding resistance conditions.
 6. Unusual space limitations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Eaton.
 2. General Electric Company.
 3. SIEMENS Industry, Inc.; Energy Management Division.
 4. Square D.

2.2 SYSTEM DESCRIPTION

- A. Description: Medium-voltage, primary incoming section; transformer section; and low-voltage secondary switchgear section; and including coordinated circuit breakers, fusible switches, and metering components.
 1. 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. Comply with IEEE C2, "National Electrical Safety Code."
 3. Comply with IEEE C37.121, "American National Standard for Switchgear Unit Substations."
 4. Comply with NFPA 70, "National Electrical Code."

2.3 MANUFACTURED UNITS

- A. Indoor Unit Arrangement: Single assembly.
- B. Connections between the primary device and transformer shall be cable or bus, and between the transformer and secondary shall be flexible bus braid unless noted otherwise.
- C. Indoor Enclosure: Steel.
- D. Unit Substation Enclosures Finish: Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.

2.4 MEDIUM-VOLTAGE TERMINAL COMPARTMENT SECTION

- A. Primary Incoming Section: Terminal assembly with adequate space for incoming-cable terminations and surge arresters, complying with NEMA SG4 and meeting thermal, mechanical, and dielectric requirements specified for the transformer section.
- B. Ratings: Suitable for application in three-phase, 60-Hz, solidly grounded-neutral system.
- C. System Voltage: 4.16 kV nominal; 4.76 kV maximum.
- D. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of any disconnecting device.

2.5 MEDIUM-VOLTAGE METAL-ENCLOSED SWITCHGEAR SECTION

- A. Metal-enclosed, air-interrupter switchgear, with fuses, complying with IEEE C37.20.3.
 - 1. Switchgear shall be arc-resistant, complying with IEEE C37.20.7.
- B. Ratings: Comply with IEEE C37.04; and suitable for application in three-phase, 60-Hz, solidly grounded-neutral system.
 - 1. System Voltage: 4.16 kV nominal; 4.76 kV maximum.
 - 2. Design Level of Available-Source Fault Current: Integrated short-circuit rating consistent with value of fault current indicated.
 - 3. Main-Bus Rating: 1600 A, continuous.
- C. Interrupter Switches: Stationary, gang operated, and suitable for application at maximum short-circuit rating of integrated switchgear assembly.
 - 1. Rating: 1200-A continuous duty and load break.
 - 2. Two-Time Duty-Cycle Fault Closing: 40,000 asymmetrical amperes.
 - 3. Switch Action: No external arc and no significant quantities of ionized gas released into the enclosure.
 - 4. Switch Construction: Supported entirely by interior framework of structure, with copper switchblades and stored-energy operating mechanism.
 - 5. Phase Barriers: Full length of switchblades and fuses for each pole; designed for easy removal; allow visual inspection of switch components if barrier is in place.
 - 6. Protective Shields: Cover live components and terminals.

- a. Fuse Mounts: Single-frame mounted and de-energized when switch is open.
 - 7. Mechanical Interlock: Prevent opening switch compartment door unless switchblades are open, and prevent closing switch if door is open.
 - 8. Window: Permits viewing switch-blade positions when door is closed.
 - 9. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
- D. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading.
- 1. Current-Limiting Fuses: Full-range, fast-replaceable, current-limiting type that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from tube.
 - 2. Indicator integral with each fuse to show when it has blown.
 - 3. Spares: Include three fuses in use and three spare fuses in storage clips in each switch.
- E. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of any disconnecting device.

2.6 MEDIUM-VOLTAGE INSTRUMENTS SECTION

- A. Instrument Transformers: Comply with IEEE C57.13.
- 1. Potential and Current Transformers: Burden and Accuracy Class suitable for connected meters.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems.
- 1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
 - 2. Switch-selectable digital display with the following features:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Three-Phase Real Power: Plus or minus 2 percent.
 - e. Three-Phase Reactive Power: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
 - 3. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

2.7 DRY-TYPE TRANSFORMER SECTION

- A. Description: IEEE C57.12.01, IEEE C57.12.50, and dry-type, two-winding, secondary unit substation transformer.

- B. Style: Indoor, ventilated, cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
- C. Cooling System: Class AA, air cooled, complying with IEEE C57.12.01.
- D. Insulation Materials: IEEE C57.12.01, rated 220 deg C.
 - 1. Insulation Temperature Rise: 150 deg C, maximum rise above 40 deg C.
- E. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, two above and two below rated primary voltage.

2.8 SECONDARY DISTRIBUTION SECTION SWITCHBOARD

- A. The secondary distribution section shall be drawout, low-voltage switchgear, complying with NEMA PB 2 and UL 891.
- B. Switchboard Structure: Front accessible.
 - 1. Comply with UL requirements for service entrance equipment
- C. Switchboard Bus:
 - 1. Use bus bars to connect compartments and vertical sections. Cable connections are not permitted.
 - 2. Main Phase Bus: Uniform capacity the entire length of section.
 - 3. Neutral Bus: 100 percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
 - 4. Vertical Section Bus: Extend to spaces for future circuit breakers.
 - 5. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
 - 6. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 1/4-by-2 inches (6 by 50 mm).
 - 7. Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
- D. Switchboard Arrangement:
 - 1. Main Disconnect Device: MCCB.
 - 2. Feeder Protective Devices: MCCBs.
- E. MCCBs (to 2500 A): Fixed-mounted, manually operated air-circuit breakers. Comply with UL 489.
 - 1. With quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, and its position is shown by the position of the handle. With manual push-to-trip push button.
 - 2. Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.

- a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
- b. With trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
- c. Time-current adjustments to achieve protective-device coordination as follows:
 - 1) Adjustable long-time delay.
 - 2) Adjustable short-time setting and delay to shape the time-current curve.
 - 3) Adjustable instantaneous setting.
 - 4) Individually adjustable ground-fault setting and time delay.
- d. With built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker. "MCCBs (1600 to 2500 A)" Paragraph below is generally available for larger frame sizes for applications requiring additional time-current tripping features.

2.9 LOW-VOLTAGE INSTRUMENTS SECTION

- A. Instrument Transformers: Comply with IEEE C57.13.
 1. Voltage Transformers: Secondary voltage rating of 120 V and NEMA C 12.11 Accuracy Class of 0.3 with burdens of W, X, and Y.
 2. Current Transformers: Burden and Accuracy Class suitable for connected relays, meters, and instruments.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems.
 1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
 2. Switch-selectable digital display with the following features:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Three-Phase Real Power: Plus or minus 2 percent.
 - e. Three-Phase Reactive Power: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
 - i. Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
 3. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.
- C. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.
- D. Surge Suppression: Factory installed as an integral part of the low-voltage switchgear, complying with UL 1449 SPD, Type 1, with the following features and accessories:
 1. Integral disconnect switch.

2. Indicator light display for protection status.
 3. Form-C contacts rated at 5 A and 250-V ac, one N.O. and one N.C., for remote monitoring of protection status.
 4. Surge counter.
- E. Control Power Supply: Control power transformer supplying 120-V control circuits through secondary disconnect devices.
- F. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
 2. Conductors sized according to NFPA 70 for duty required.
- G. Maintenance Tools: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.
1. Racking handle to manually move circuit breaker between "connected" and "disconnected" positions.
 2. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchboard.
 3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
 4. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

2.10 IDENTIFICATION DEVICES

- A. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 0553 "Identification for Electrical Systems."

2.11 SOURCE QUALITY CONTROL

- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear and switchboard tests according to NEMA C37.51.
- B. Factory Tests: Perform the following factory-certified tests on each secondary unit substation:
1. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
 2. Ratios on the rated voltage connection and on tap extreme connections.
 3. Polarity and phase relation on the rated voltage connection.
 4. No-load loss at rated voltage on the rated voltage connection.
 5. Exciting current at rated voltage on the rated voltage connection.
 6. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
 7. Applied potential.
 8. Induced potential.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of the Work.
- B. Examine roughing-in of conduits and grounding systems to verify the following:
 - 1. Wiring entries comply with layout requirements.
 - 2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross section barriers to reach load or line lugs.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.
- D. Verify that ground connections are in place and that requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at secondary unit substation location.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with applicable portions of NECA 1, NECA 400, NECA 410, NECA 430, and NEMA SG 11.
- B. Install secondary unit substations on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 3000 "Cast-in-Place Concrete."
- C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."
 - 1. Install the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 ft. (9 m) apart.
 - 2. Install arc-flash warning labels specified in Section 26 0573.19 "Arc-Flash Hazard Analysis."
- B. Operating Instructions: Place printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures with the maintenance materials.

3.4 CONNECTIONS

- A. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."

1. At Interior Locations: For grounding to grounding electrodes, use bare copper cable not smaller than No. 4/0 AWG. Bond surge arrester and neutrals directly to the transformer enclosure and then to the grounding electrode system with bare copper conductors. Keep leads as short as practicable with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.

- B. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 CLEANING

- A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.

- B. General Field Testing Requirements:

1. Comply with the provisions of NFPA 70B Ch. "Testing and Test Methods."
2. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
3. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation is tested at the specified value or less.
4. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
5. Visual and Mechanical Inspection:
 - a. Verify equipment nameplate data complies with Contract Documents.
 - b. Inspect bolted electrical connections for high resistance using one of the following two methods:
 - 1) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
6. Remove and replace malfunctioning units and retest.
7. Prepare test and inspection reports. Record as-left set points of all adjustable devices.

- C. Switchgear Field Tests:

1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.

- b. Inspect anchorage, alignment, grounding, and required area clearances.
 - c. Verify the unit is clean and shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
 - d. Verify that fuse and circuit-breaker sizes and types correspond to Drawings and coordination study as well as the address of the circuit breaker that is used to identify it in microprocessor-communication software.
 - e. Verify that current and voltage-transformer ratios correspond to Drawings.
 - f. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
 - 1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
 - 2) Make key exchange with devices operated in off-normal positions.
 - g. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 - h. Inspect insulators for evidence of physical damage or contaminated surfaces.
 - i. Verify correct barrier and shutter installation and operation.
 - j. Exercise all active components.
 - k. Inspect mechanical indicating devices for correct operation.
 - l. Verify that filters are in place and vents are clear.
 - m. Inspect control power transformers as follows:
 - 1) Inspect for physical damage, cracked insulation, broken leads, connection tightness, defective wiring, and overall general condition.
 - 2) Verify that primary- and secondary-use or circuit-breaker ratings match Drawings and comply with manufacturer's recommendations.
 - 3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.
2. Electrical Tests:
- a. Perform dc voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If the temperature of the bus is other than plus or minus 20 deg. C, adjust the resulting resistance as provided in NETA ATS Table 100.11.
 - 1) Insulation-resistance values of bus insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
 - 2) Do not proceed to the dielectric-withstand-voltage tests until insulation-resistance levels are raised above minimum values.
 - b. Perform a dielectric-withstand-voltage test on each bus section, each phase-to-ground with phases not under test grounded, according to manufacturer's published data. If manufacturer has no recommendation for this test, it shall be conducted according to NETA ATS, Table 100.2. Apply the test voltage for one minute.

- 1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.
 - c. Voltage Transformers:
 - 1) Perform secondary wiring integrity test. Verify correct potential at all devices.
 - 2) Verify secondary voltages by energizing the primary winding with system voltage.
 - d. Perform current-injection tests on the entire current circuit in each section of switchgear.
 - 1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
 - 2) Perform current tests by primary injection with magnitudes such that a minimum of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
 - e. Verify operation of space heaters.
 - f. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.
- D. Medium-Voltage Surge Arrester Field Tests:
1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify the arresters are clean.
 - d. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
 - e. Verify that the stroke counter is correctly mounted and electrically connected if applicable. Record the stroke counter reading.
 2. Electrical Test:
 - a. Perform an insulation-resistance test on each arrester, phase terminal-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in the table.
 - b. Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.
- E. Instrument Transformer Field Tests:
1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.

- b. Verify correct connection of transformers with system requirements.
 - c. Verify that adequate clearances exist between primary and secondary circuit wiring.
 - d. Verify the unit is clean.
 - e. Verify that all required grounding and shorting connections provide contact.
 - f. Verify correct operation of transformer withdrawal mechanism and grounding operation.
 - g. Verify correct primary- and secondary-fuse sizes for voltage transformers.
 - h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
2. Electrical Tests of Current Transformers:
- a. Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1000-V dc for one minute. For units with solid-state components that cannot tolerate the applied voltage, comply with manufacturer's recommendations. Insulation-resistance values of instrument transformers shall not be less than values shown in NETA ATS, Table 100.5.
 - b. Perform a polarity test of each current transformer according to IEEE C57.13.1. Polarity results shall agree with transformer markings.
 - c. Perform a ratio-verification test using the voltage or current method according to IEEE C57.13.1. Ratio errors shall comply with IEEE C57.13.
 - d. Perform an excitation test on transformers used for relaying applications according to IEEE C57.13.1. Excitation results shall match the curve supplied by the manufacturer or shall comply with IEEE C57.13.1.
 - e. Measure current circuit burdens at transformer terminals according to IEEE C57.13.1. The measured burdens shall match the instrument transformer Accuracy Class rating.
 - f. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data. Power-factor or dissipation-factor values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with test equipment manufacturer's published data.
 - g. Verify that current-transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3.
3. Electrical Tests of Voltage and Potential Transformers:
- a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply the test voltage for one minute according to NETA ATS, Table 100.5. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's recommendations. Insulation-resistance values of instrument transformers shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5.
 - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Test voltages shall be applied for one minute according to NETA ATS, Table 100.5. Insulation-resistance values of the transformers shall not be less than values shown in NETA ATS, Table 100.5
 - c. Perform a polarity test on each transformer to verify the polarity marks or H(1)-X(1) relationship. Polarity results shall agree with transformer markings.
 - d. Perform a turns-ratio test on all tap positions. Ratio errors shall not exceed the tolerances specified in IEEE C57.13.

- e. Measure voltage circuit burdens at transformer terminals. Measured burdens shall be compared to instrument transformer ratings. The measured burdens shall match the instrument transformer Accuracy Class rating.
- f. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data. Power-factor or dissipation-factor values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with test equipment manufacturer's published data.
- g. Verify that voltage-transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3.

F. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:

- a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
- b. Verify operation of light-emitting diodes, display, and targets.
- c. Record passwords for each access level.
- d. Clean the front panel and remove foreign material from the case.
- e. Check tightness of connections.
- f. Verify that the frame is grounded according to manufacturer's instructions.
- g. Set the relay according to results in Section 26 0573.16 "Coordination Studies" and in Section 26 0573.19 "Arc-Flash Hazard Analysis."
- h. Download settings from the relays. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.

2. Electrical Tests:

- a. Perform insulation-resistance tests from each circuit to the grounded frame according to manufacturer's published data.
- b. Apply voltage or current to all analog inputs, and verify correct registration of the relay meter functions.
- c. Functional Operation: Check functional operation of each element used in the protection scheme.

G. Dry-Type Transformer Section Field Tests:

1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
- b. Inspect anchorage, alignment, and grounding.
- c. Verify that resilient mounts are free and that any shipping brackets have been removed.
- d. Verify the unit is clean.
- e. Perform specific inspections and mechanical tests recommended by the manufacturer.
- f. Verify that as-left tap connections are as specified.
- g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

- a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence

of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index shall not be less than 1.0.

- b. Perform turns-ratio tests at all tap positions. The test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If the test fails, replace the transformer.
- c. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

H. Low-Voltage Power Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
- b. Inspect anchorage, alignment, and grounding.
- c. Verify that all maintenance devices are available for servicing and operating the breaker.
- d. Verify the unit is clean.
- e. Verify that the arc chutes are intact.
- f. Inspect moving and stationary contacts for condition and alignment.
- g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
- h. Perform mechanical operator and contact alignment tests on both the breaker and its operating mechanism according to manufacturer's published data.
- i. Verify cell fit and element alignment.
- j. Verify racking mechanism operation.
- k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
- l. Perform adjustments for final protective-device settings according to coordination study provided by end user.
- m. Record as-found and as-left operation counter readings.

2. Electrical Tests:

- a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations shall be investigated.
- b. Measure contact resistance across each power contact of the circuit breaker. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- c. Determine long-time pickup and delay by primary current injection. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS, Table 100.7.

- d. Determine short-time pickup and delay by primary current injection. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
 - e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
 - f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
 - g. Test functions of the trip unit by means of secondary injection. Pickup values and trip characteristic shall be as specified and within manufacturer's published tolerances.
 - h. Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall conform to the manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
 - i. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - j. Verify correct operation of any auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, antipump function, and trip unit battery condition. Reset all trip logs and indicators. Auxiliary features shall operate according to manufacturer's published data.
 - k. Verify operation of charging mechanism. The charging mechanism shall operate according to manufacturer's published data.
- I. Molded-Case Air-Circuit-Breaker Field Tests:
- 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage and alignment.
 - c. Verify the unit is clean.
 - d. Operate the circuit breaker to ensure smooth operation.
 - e. Inspect operating mechanism, contacts, and arc chutes in unsealed units.
 - f. Perform adjustments for final protective-device settings according to the coordination study. Set the protective devices according to results in Section 26 0573.16 "Coordination Studies" and in Section 26 0573.19 "Arc-Flash Hazard Analysis."
 - 2. Electrical Tests:
 - a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with the circuit breaker closed, and across each open pole. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations shall be investigated.
 - b. Perform a contact/pole-resistance test. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values

- that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- c. Determine long-time pickup and delay by primary current injection. Ground-fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band, including adjustment factors.
 - d. Determine short-time pickup and delay by primary current injection. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
 - e. Determine ground-fault pickup and time delay by primary current injection. Ground-fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
 - f. Determine instantaneous pickup by primary current injection. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
 - g. Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall conform to the manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
 - h. Verify correct operation of auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, anti-pump function, and trip unit battery condition. Reset all trip logs and indicators. Auxiliary features shall operate according to manufacturer's published data.
 - i. Verify operation of charging mechanism. The charging mechanism shall operate according to manufacturer's published data.
- J. Low-Voltage Ground-Fault Protection System Field Tests:
- 1. Visual and Mechanical Inspection:
 - a. Inspect the components for damage and errors in polarity or conductor routing.
 - 1) Verify that ground connection is made on the source side of the neutral disconnect link and on the source side of any ground-fault sensor.
 - 2) Verify that the neutral sensors are connected with correct polarity on both primary and secondary.
 - 3) Verify that phase conductors and the neutral pass through the sensor in the same direction for zero sequence systems.
 - 4) Verify that grounding conductors do not pass through zero sequence sensors.
 - 5) Verify that grounded conductor is solidly grounded.
 - b. Verify the unit is clean.
 - c. Operate the circuit breaker to ensure smooth operation.
 - d. Verify correct operation of functions of the self-test panel if provided.
 - e. Verify that the control power transformer has adequate capacity for the system.
 - f. Set pickup and time-delay settings according to "Quality Control" Article. Record appropriate operation and test sequences according to NFPA 70, "Services" Article, "Ground-Fault Protection Equipment" Section.
 - 2. Electrical Tests:

- a. Measure the system neutral-to-ground insulation resistance with the neutral disconnect link temporarily removed. Replace the neutral disconnect link after testing. System neutral-to-ground insulation resistance shall be a minimum of 1 megohm. Correct wiring until the minimum is achieved.
- b. Perform ground-fault protective-device pickup tests using primary injection. Results of pickup test shall be greater than 90 percent of the ground-fault protective-device pickup setting and less than 1200 A or 125 percent of the pickup setting, whichever is smaller. Adjust or replace the device until these parameters are achieved.
- c. For summation-type systems utilizing phase and neutral current transformers, verify correct polarities by applying current to each phase-neutral current-transformer pair. This test also applies to MCCBs utilizing an external neutral current transformer. The ground-fault protective device shall operate when current direction is the same relative to polarity marks in the two current transformers. The ground-fault protective device shall not operate when current direction is opposite relative to polarity marks in the two current transformers.
- d. Measure time delay of the ground-fault protective device at a value equal to or greater than 150 percent of the pickup value. Relay timing shall be according to manufacturer's published data but shall be no longer than one second at 3000 A according to NFPA 70, "Services" Article, "Ground-Fault Protection Equipment" Section.
- e. Verify reduced control voltage tripping capability is 55 percent for ac systems and 80 percent for dc systems. Replace the ground-fault system if the reduced control voltage tripping requirement is not achieved, and retest.

K. Metering Device Field Tests:

1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
- b. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
- c. Verify the unit is clean.
- d. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:

- a. Verify accuracy of meters at all cardinal points. Meter accuracy shall be according to manufacturer's published data.
- b. Calibrate meters according to manufacturer's published data. Calibration results shall be within manufacturer's published tolerances.
- c. Verify all instrument multipliers. Instrument multipliers shall be according to system design specifications.
- d. Verify that current-transformer and voltage-transformer secondary circuits are intact. Test results shall confirm the integrity of the secondary circuits of current and voltage transformers.

3.7 FOLLOW-UP SERVICE

- A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
 - a. Adjust transformer taps.
 - b. Rebalance loads.
 - c. Prepare written request for voltage adjustment by electric utility.
3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
4. Report:
 - a. Prepare a written report covering monitoring performed and corrective action taken.
 - b. For each relay and adjustable circuit breaker, tag the device with adjusting technician's initials and the date of the adjustment. Record the settings and file with test records specified in "Field Quality Control" Article.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems.

END OF SECTION 26 1116.12

SECTION 26 2416

PANELBOARDS

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. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Load centers.
 - 4. Electronic-grade panelboards.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details.
 - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.

3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of NRTL listing for SPD as installed in panelboard.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include wiring diagrams for power, signal, and control wiring.
9. Key interlock scheme drawing and sequence of operations.
10. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Panelboard Schedules: For installation in panelboards. [**Submit final versions after load balancing.**]

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.9 FIELD CONDITIONS

- A. Environmental Limitations:
 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards 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.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
 - B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 1. Ambient temperatures within limits specified.
 2. Altitude not exceeding 6600 feet (2000 m).
 - C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 1. Notify [Architect] [Construction Manager] [Owner] no fewer than two days in advance of proposed interruption of electric service.
 2. Do not proceed with interruption of electric service without [Architect's] [Construction Manager's] [Owner's] written permission.
 3. Comply with NFPA 70E, "Standard for Electrical Safety in the Workplace."
- 1.10 WARRANTY
- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.
 - B. **[Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.]**
 1. **SPD Warranty Period: Five years from date of Substantial Completion.]**

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- 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. Comply with NEMA PB 1, "Panelboards."
- D. Comply with NFPA 70, "National Electrical Code."
- E. Enclosures: **[Flush] [and] [Surface]**-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. **[Kitchen] [Wash-Down]** Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, **[Type 5] [Type 12]**.
 2. Height: **84 inches (2.13 m)** maximum.
 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
 4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
 5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 7. Finishes:
 - a. Panels and Trim: **[Steel] [and] [galvanized steel]**, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: **[Galvanized steel] [Same finish as panels and trim]**.
- F. Phase, Neutral, and Ground Buses:
1. Material: **[Tin-plated aluminum] [Hard-drawn copper, 98 percent conductivity]**.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 4. **[Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.]**
 5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
 6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.
- G. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Terminations shall allow use of 75 deg C rated conductors without derating.

3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
 6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
 9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- H. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- I. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Percentage of Future Space Capacity: 20 percent.
- J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.
- ## 2.2 PERFORMANCE REQUIREMENTS
- A. **[Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD [Type 1] [Type 2].]**
- ## 2.3 POWER PANELBOARDS
- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. [Eaton Electrical Sector; Eaton Corporation.](#)
 2. [General Electric Company; GE Energy Management - Electrical Distribution.](#)
 3. [Siemens Energy.](#)
 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than **[36 inches (914 mm)]** <Insert dimension> high, provide two latches, keyed alike.
 - D. Mains: **[Circuit breaker] [Fused switch] [Lugs only]**.
 - E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: **[Plug-in circuit breakers] [Bolt-on circuit breakers] [Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal]**.
 - F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: **[Bolt-on circuit breakers] [Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal]**.
 - G. **[Contactors in Main Bus: NEMA ICS 2, Class A, [electrically] [mechanically] held, general-purpose controller, with same short-circuit interrupting rating as panelboard.]**
 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
 2. External Control-Power Source: 120-V branch circuit.
- 2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS
- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 1. [Eaton Electrical Sector; Eaton Corporation.](#)
 2. [General Electric Company; GE Energy Management - Electrical Distribution.](#)
 3. [Siemens Energy.](#)
 4. Square D; a brand of Schneider Electric.
 - B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
 - C. Branch Overcurrent Protective Devices: **[Plug-in] [Bolt-on]** circuit breakers, replaceable without disturbing adjacent units.
 - D. Contactors in Main Bus: NEMA ICS 2, Class A, **[electrically] [mechanically]** held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
 2. External Control-Power Source: 120-V branch circuit.
 - E. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall be retained with screws. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.
 - F. Column-Type Panelboards: Single row of overcurrent devices **[with narrow gutter extension] [and] [overhead junction box equipped with ground and neutral terminal buses]**.
 1. Doors: Concealed hinges secured with multipoint latch with tumbler lock; keyed alike.

2.5 LOAD CENTERS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. [Eaton Electrical Sector; Eaton Corporation.](#)
 2. [General Electric Company; GE Energy Management - Electrical Distribution.](#)
 3. [Siemens Energy.](#)
 4. Square D; a brand of Schneider Electric.
- B. Load Centers: Comply with UL 67.
- C. Mains: **[Circuit breaker] [or] [lugs only]**.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.
- F. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.6 ELECTRONIC-GRADE PANELBOARDS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. [Eaton Electrical Sector; Eaton Corporation.](#)
 2. [General Electric Company; GE Energy Management - Electrical Distribution.](#)
 3. [Siemens Energy.](#)
 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1; with factory-installed, integral SPD; labeled by an NRTL for compliance with UL 67 and UL 1449 after installing SPD.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- F. SPD.
1. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
 2. Protection modes and UL 1449 VPR for grounded wye circuits with **[480Y/277 V] [208Y/120 V]**, three-phase, four-wire circuits shall not exceed the following:
 - a. Line to Neutral: **[1200 V for 480Y/277 V] [700 V for 208Y/120 V]**.
 - b. Line to Ground: **[1200 V for 480Y/277 V] [700 V for 208Y/120 V]**.
 - c. Neutral to Ground: **[1200 V for 480Y/277 V] [700 V for 208Y/120 V]**.
 - d. Line to Line: **[2000 V for 480Y/277 V] [1200 V for 208Y/120 V]**.

3. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
 - a. Line to Neutral: 700 V.
 - b. Line to Ground: 700 V.
 - c. Neutral to Ground: 700 V.
 - d. Line to Line: 1200 V.
4. SCCR: Equal to **[the SCCR of the panelboard in which installed] [or exceed 100 kA] [or exceed 200 kA]**.
5. Nominal Rating: **[20 kA] [10 kA]**.

G. Buses:

1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
2. Copper equipment and isolated ground buses.

2.7 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Sector; Eaton Corporation.
2. General Electric Company; GE Energy Management - Electrical Distribution.
3. Siemens Energy.
4. Square D; a brand of Schneider Electric.

B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
 6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
 7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 8. Subfeed Circuit Breakers: Vertically mounted.
 9. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
 - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - g. Communication Capability: [**Circuit-breaker-mounted**] [**Universal-mounted**] [**Integral**] [**Din-rail-mounted**] communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
 - h. Shunt Trip: [**120-V**] [**24-V**] trip coil energized from separate circuit, set to trip at [**55**] [**75**] percent of rated voltage.
 - i. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage [**without intentional**] [**with field-adjustable 0.1- to 0.6-second**] time delay.
 - j. Rating Plugs: Three-pole breakers with ampere ratings greater than [**150**] <Insert value> amperes shall have interchangeable rating plugs or electronic adjustable trip units.
 - k. Auxiliary Contacts: [**One, SPDT switch**] [**Two, SPDT switches**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - l. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - m. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - n. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
 - o. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
 - p. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in [**on**] [**off**] [**on or off**] position.
 - q. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
 2. Fused Switch Features and Accessories:
 - a. Standard ampere ratings and number of poles.

- b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.
- c. Auxiliary Contacts: **[One]** **[Two]** normally open and normally closed contact(s) that operate with switch handle operation.

2.8 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in **[transparent card holder]** **[metal frame with transparent protective cover]**.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.
- D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.9 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to **[NECA 407]** **[NEMA PB 1.1]**.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1, "Standard Practice for Good Workmanship in Electrical Construction."
- C. Install panelboards and accessories according to NECA 407.
- D. Equipment Mounting:
 - 1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in **[Section 033000 "Cast-in-Place Concrete."]** **[Section 033053 "Miscellaneous Cast-in-Place Concrete."]**
 - 2. Attach panelboard to the vertical finished or structural surface behind panelboard.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Mount top of trim **[90 inches (2286 mm)]** above finished floor unless otherwise indicated.
- G. Mount panelboard cabinet plumb and rigid without distortion of box.
- H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- I. Mount surface-mounted panelboards to steel slotted supports **[5/8 inch (16 mm)]** **[1 1/4 inch (32 mm)]** in depth. Orient steel slotted supports vertically.
- J. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- L. Install filler plates in unused spaces.
- M. Stub four **1-inch (25 mm)** empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four **1-inch (25 mm)** empty conduits into raised floor space or below slab not on grade.

N. Arrange conductors in gutters into groups and bundle and wrap with wire ties[**after completing load balancing**].

O. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads[**after balancing panelboard loads**]; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. 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.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers[**and low-voltage surge arrestors**] stated in NETA ATS, Paragraph 7.6 Circuit Breakers[**and Paragraph 7.19.1 Surge Arrestors, Low-Voltage**]. Do not perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.

- b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
- c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges **[as indicated] [as specified in Section 260573.16 "Coordination Studies."]**
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
 - 1. Measure loads during period of normal facility operations.
 - 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
 - 4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 2416

SECTION 26 2726

WIRING DEVICES

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. Straight-blade convenience, hospital-grade, isolated-ground, and tamper-resistant receptacles.
2. USB charger devices.
3. GFCI receptacles.
4. SPD receptacles.
5. Hazardous (classified) location receptacles.
6. Twist-locking receptacles.
7. Pendant cord-connector devices.
8. Cord and plug sets.
9. Toggle switches.
10. Decorator-style convenience.
11. Wall switch sensor light switches with dual technology sensors.
12. Wall switch sensor light switches with passive infrared sensors.
13. Wall switch sensor light switches with ultrasonic sensors.
14. Digital timer light switches.
15. Wall-box dimmers.
16. Wall plates.
17. Floor service outlets.
18. Poke-through assemblies.
19. Prefabricated multioutlet assemblies.
20. Service poles.

1.3 DEFINITIONS

- A. Abbreviations of Manufacturers' Names:

1. Eaton (Arrow Hart).
2. Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
3. Leviton: Leviton Mfg. Company, Inc.
4. Pass & Seymour: Pass& Seymour/Legrand.

- B. BAS: Building automation system.

- C. EMI: Electromagnetic interference.

- D. GFCI: Ground-fault circuit interrupter.
- E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- F. RFI: Radio-frequency interference.
- G. SPD: Surge protective device.
- H. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. [Samples: One for each type of device and wall plate specified, in each color specified.]**

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70, "National Electrical Code."
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 - 2. Devices shall comply with the requirements in this Section.
- D. Devices for Owner-Furnished Equipment:
 - 1. Receptacles: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.
- E. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STRAIGHT-BLADE RECEPTACLES

- A. Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell.
 - c. Leviton.
 - d. Pass & Seymour.
- B. **[Hospital-Grade, Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.**
1. **Manufacturers: Subject to compliance with requirements, provide products by one of the following:**
 - a. **Eaton (Arrow Hart).**
 - b. **Hubbell.**
 - c. **Leviton.**
 - d. **Pass & Seymour.**
 2. **Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.]**
- C. Isolated-Ground, Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell.
 - c. Leviton.
 - d. Pass & Seymour.
 2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
- D. Tamper-Resistant Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell.
 - c. Leviton.

d. Pass & Seymour.

2. Description: Labeled and complying with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.3 USB CHARGER DEVICES

- A. Tamper-Resistant, USB Charger Receptacles: 12 V dc, 2.0 A, USB Type A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1310, and FS W-C-596.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell.
 - c. Leviton.
 - d. Pass & Seymour.
2. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
3. USB Receptacles: **[Single] [Dual] [Quad]**, Type A.
4. Line Voltage Receptacles: **[Single] [Dual]**, two pole, three wire, and self-grounding.

- B. **[Hospital-Grade, USB Charger Receptacles: 12 V dc, 2.0 A, USB Type A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, UL 1310, and FS W-C-596.**

1. **Manufacturers: Subject to compliance with requirements, provide products by one of the following:**
 - a. **Eaton (Arrow Hart).**
 - b. **Hubbell.**
 - c. **Leviton.**
 - d. **Pass & Seymour.**
2. **Description: Labeled and complying with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.**
3. **USB Receptacles: [Single] [Dual] [Quad], Type A.**
4. **Line Voltage Receptacles: [Single] [Dual], two pole, three wire, and self-grounding].**

2.4 GFCI RECEPTACLES

- A. General Description:

1. 125 V, 20 A, straight blade, non-feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

- B. Duplex GFCI Convenience Receptacles:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

- a. Eaton (Arrow Hart).
 - b. Hubbell.
 - c. Leviton.
 - d. Pass & Seymour.
- C. Tamper-Resistant, Duplex GFCI Convenience Receptacles:
- 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell.
 - b. Pass & Seymour.
 - c. Eaton (Arrow Hart).
- D. **[Hospital-Grade, Duplex GFCI Convenience Receptacles: Comply with UL 498 Supplement sd.**
- 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell.
 - c. Leviton.
 - d. Pass & Seymour.]

2.5 SPD RECEPTACLES

- A. General Description: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1449, and FS W-C-596, with integral SPD in line to ground, line to neutral, and neutral to ground.
- 1. 125 V, 20 A, straight-blade type.
 - 2. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
 - 3. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
- B. Duplex SPD Convenience Receptacles:
- 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell.
 - c. Leviton.
 - d. Pass & Seymour.
- C. **[Isolated-Ground, Duplex SPD Convenience Receptacles:**
- 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

- a. **Eaton (Arrow Hart).**
 - b. **Hubbell.**
 - c. **Leviton.**
 - d. **Pass & Seymour.**
 2. **Grounding: Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.]**
- D. **[Hospital-Grade, Duplex SPD Convenience Receptacles: Comply with UL 498 Supplement sd.**
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. **Eaton (Arrow Hart).**
 - b. **Hubbell.**
 - c. **Leviton.**
 - d. **Pass & Seymour.]**
- E. **[Isolated-Ground Hospital-Grade Duplex SPD Convenience Receptacles: Comply with UL 498 Supplement sd.**
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. **Eaton (Arrow Hart).**
 - b. **Hubbell.**
 - c. **Leviton.**
 - d. **Pass & Seymour.**
 2. **Grounding: Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.]**
- 2.6 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES
- A. Hazardous (Classified) Locations Receptacles: Comply with NEMA FB 11 and UL 1010.
1. **Manufacturers:** Subject to compliance with requirements, provide products by the following:
 - a. Eaton (Arrow Hart).
 - b. EGS/Appleton Electric.
 - c. Killark; Division of Hubbell, Inc.
- 2.7 TWIST-LOCKING RECEPTACLES
- A. Twist-Lock, Single Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. **Hubbell.**
 - c. **Leviton.**
 - d. **Pass & Seymour.**

B. [Twist-Lock, Isolated-Ground, Single Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.]

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. **Hubbell.**
 - c. **Leviton.**
 - d. **Pass & Seymour.**
2. **Grounding:** Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.8 PENDANT CORD-CONNECTOR DEVICES

A. Description:

1. Matching, locking-type plug and receptacle body connector.
2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.9 CORD AND PLUG SETS

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.10 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Single Pole:

- a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

- 1) Eaton (Arrow Hart).
- 2) Hubbell.
- 3) Leviton.
- 4) Pass & Seymour.

2. Two Pole:

- a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

- 1) Eaton (Arrow Hart).
- 2) Hubbell.
- 3) Leviton.
- 4) Pass & Seymour.

3. Three Way:

- a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

- 1) Eaton (Arrow Hart).
- 2) Hubbell.
- 3) Leviton.
- 4) Pass & Seymour.

4. Four Way:

- a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

- 1) Eaton (Arrow Hart).
- 2) Hubbell.
- 3) Leviton.
- 4) Pass & Seymour.

C. Pilot-Light Switches: 120/277 V, 20 A.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

- a. Eaton (Arrow Hart).
- b. Hubbell.
- c. Leviton.
- d. Pass & Seymour.

2. Description: Single pole, with LED-lighted handle, illuminated when switch is off.

D. Key-Operated Switches: 120/277 V, 20 A.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

- a. Eaton (Arrow Hart).
- b. Hubbell.
- c. Leviton.
- d. Pass & Seymour.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

- a. Eaton (Arrow Hart).
- b. Hubbell.
- c. Leviton.
- d. Pass & Seymour.

F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

- a. Eaton (Arrow Hart).
- b. Hubbell.
- c. Leviton.
- d. Pass & Seymour.

2.11 DECORATOR-STYLE DEVICES

A. Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

- a. Eaton (Arrow Hart).
- b. Hubbell.
- c. Leviton.
- d. Pass & Seymour.

B. Tamper-Resistant Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. **Hubbell.**
 - c. **Leviton.**
 - d. **Pass & Seymour.**
 2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.
- C. Tamper-Resistant and Weather-Resistant Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. **Hubbell.**
 - c. **Leviton.**
 - d. **Pass & Seymour.**
 2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section, when installed in wet and damp locations.
- D. GFCI, Non-Feed-Through Type, Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. **Hubbell.**
 - c. **Leviton.**
 - d. **Pass & Seymour.**
- E. GFCI, Tamper-Resistant and Weather-Resistant Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. **Hubbell.**
 - c. **Pass & Seymour.**
 2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.

- F. Toggle Switches: Square Face, 120/277 V, 15 A; comply with NEMA WD 1, UL 20, and FS W-S-896.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell.
 - c. Leviton.
 - d. Pass & Seymour.

- G. Lighted Toggle Switches: Square Face, 120 V, 15 A; comply with NEMA WD 1 and UL 20.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell.
 - c. Leviton.
 - d. Pass & Seymour.
2. Description: With LED-lighted handle, illuminated when switch is off.

2.12 WALL SWITCH SENSOR LIGHT SWITCH, DUAL TECHNOLOGY

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. Eaton (Arrow Hart).
 2. Hubbell.
 3. Leviton.
 4. Pass & Seymour.
- B. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual technology.
1. Connections: Provisions for connection to BAS.
 2. Connections: Hard wired.
 3. Connections: Wireless.
 4. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 A at 277-V ac for fluorescent or LED lighting, and 1/4 hp at 120-V ac.
 5. Integral relay for connection to BAS.
 6. Adjustable time delay of [five] [10] [15] [20] minutes.
 7. Able to be locked to [Automatic-On] [Manual-On] mode.
 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux).
 9. Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.13 WALL SWITCH SENSOR LIGHT SWITCH, PASSIVE INFRARED

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries.
2. Hubbel Premise Wiring.
3. Leviton.
4. Pass & Seymour.

B. Description: Switchbox-mounted, combination, lighting-control sensor and conventional switch lighting-control unit using passive infrared technology.

1. Connections: Provisions for connection to BAS.
2. Connections: Hard wired.
3. Connections: Wireless.
4. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 A at 277-V ac for fluorescent or LED lighting, and 1/4 hp at 120-V ac.
5. Integral relay for connection to BAS.
6. Adjustable time delay of [five] [10] [15] [20] minutes.
7. Able to be locked to [Automatic-On] [Manual-On] mode.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux).
9. Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.14 WALL SWITCH SENSOR LIGHT SWITCH, ULTRASONIC

A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. Eaton (Arrow Hart).
2. Hubbell.
3. Leviton.

B. Description: Switchbox-mounted, combination, lighting-control sensor and conventional switch lighting-control unit using ultrasonic technology.

1. Connections: Provisions for connection to BAS.
2. Connections: Hard wired.
3. Connections: Wireless.
4. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 A at 277-V ac for fluorescent or LED lighting, and 1/4 hp at 120-V ac.
5. Integral relay for connection to BAS.
6. Adjustable time delay of [five] [10] [15] [20] minutes.
7. Able to be locked to [Automatic-On] [Manual-On] mode.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux).
9. Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.15 DIGITAL TIMER LIGHT SWITCH

A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. Eaton (Arrow Hart).
2. Hubbell.
3. Leviton.

- B. Description: Switchbox-mounted, combination digital timer and conventional switch lighting-control unit, with backlit digital display, with selectable time interval in [10] [20]-minute increments.
 - 1. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 A at 277-V ac for fluorescent or LED lighting, and 1/4 hp at 120-V ac.
 - 2. Integral relay for connection to BAS.

2.16 RESIDENTIAL DEVICES

- A. Residential-Grade, Tamper-Resistant Convenience Receptacles: 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.
 - 1. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.
- B. Weather-Resistant and Tamper-Resistant Convenience Receptacles: 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.
 - 1. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section, when installed in wet and damp locations.
- C. Fan-Speed Controls:
 - 1. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.
 - 2. Comply with UL 1917.
 - 3. Continuously adjustable [slider] [toggle switch] [rotary knob], [5] [1.5] A.
 - 4. Three-speed adjustable [slider] [rotary knob], 1.5 A.
- D. Telephone Outlet:
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Leviton.
 - 2. Description: Single RJ-45 jack for terminating Category 5e, twisted pair cable complying with Section 26 0523 "Control-Voltage Electrical Power Conductors."

2.17 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable [slider] [toggle switch] [rotary knob]; with single-pole or three-way switching. Comply with UL 1472.
- C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 600 W; dimmers shall require no derating when ganged with other devices. [**Illuminated when "off."**]
2. **<Insert wattage ratings and descriptions>**.

- D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
- E. LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.18 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material for Finished Spaces: [**Steel with white baked enamel, suitable for field painting**] [**Smooth, high-impact thermoplastic**] [**0.035-inch- (1-mm-) thick, satin-finished, Type 302 stainless steel**] [**0.04-inch- (1-mm-) thick, brushed brass with factory polymer finish**] [**0.05-inch- (1.2-mm-) thick, anodized aluminum**] [**0.04-inch- (1-mm-) thick steel with chrome-plated finish**].
 3. Material for Unfinished Spaces: [**Galvanized steel**] [**Smooth, high-impact thermoplastic**].
 4. Material for Damp Locations: [**Thermoplastic**] [**Cast aluminum**] with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant[, **die-cast aluminum**] [**thermoplastic**] with lockable cover.

2.19 FLOOR SERVICE FITTINGS

- A. Type: Modular, [**flush-type**] [**flap-type**] [**above-floor**], dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: [**Rectangular**] [**Round**], [**die-cast aluminum**] [**solid brass**] with satin finish.
- D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Data Communication Outlet: [**Blank cover with bushed cable opening.**] [**Two modular, keyed, color-coded, RJ-45 jacks for UTP cable complying with requirements in Section 27 1500 "Communications Horizontal Cabling."**]

2.20 POKE-THROUGH ASSEMBLIES

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. **Hubbell.**
 2. **Pass & Seymour/Legrand.**

3. Square D/Schneider.
4. Thomas & Betts.
5. Wiremold/Legrand.

B. Description:

1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
2. Comply with UL 514 scrub water exclusion requirements.
3. Service-Outlet Assembly: [**Pedestal type with services indicated**] [**Flush type with two simplex receptacles and space for two RJ-45 jacks**] [**Flush type with four simplex receptacles and space for four RJ-45 jacks**] complying with requirements in Section 27 1513 "Communications Copper Horizontal Cabling."
4. Size: Selected to fit nominal [**3-inch (75-mm)**] [**4-inch (100-mm)**] cored holes in floor and matched to floor thickness.
5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
6. Closure Plug: Arranged to close unused [**3-inch (75-mm)**] [**4-inch (100-mm)**] cored openings and reestablish fire rating of floor.
7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of [**two**] [**four**], four-pair cables that comply with requirements in Section 27 1513 "Communications Copper Horizontal Cabling."

2.21 PREFABRICATED MULTIOUTLET ASSEMBLIES

A. **Manufacturers:** Subject to compliance with requirements, provide products by the following:

1. **Hubbell.**
2. Wiremold/Legrand.

B. Description:

1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: [**Metal, with manufacturer's standard finish**] [**PVC**].

D. Multioutlet Harness:

1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
2. Receptacle Spacing: [**6 inches (150 mm)**] [**9 inches (230 mm)**] [**12 inches (300 mm)**] [**18 inches (460 mm)**].
3. Wiring: No. 12 AWG solid, Type THHN copper, [**single circuit**] [**two circuit, connecting alternating receptacles**].

2.22 SERVICE POLES

A. Description:

1. Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
2. Poles: Nominal **2.5-inch- (65-mm-)** square cross section, with height adequate to extend from floor to at least **6 inches (150 mm)** above ceiling, and with separate channels for power wiring and voice and data communication cabling.
3. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
4. Finishes: [**Manufacturer's standard painted finish and trim combination**] [**Satin-anodized aluminum**].
5. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, four-pair, Category 3 or Category 5 voice and data communication cables.
6. Power Receptacles: Two duplex, 20-A, straight-blade receptacles complying with requirements in this Section.
7. Data Communication Outlets: [**Blank insert with bushed cable opening**] [**Two RJ-45 jacks**] [**Four RJ-45 jacks**] complying with requirements in Section 27 1513 "Communications Copper Horizontal Cabling."

2.23 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: [**Almond**] [**Black**] [**Brown**] [**Gray**] [**Ivory**] [**White**] [**As selected by Architect**] <Insert color> unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: [**Red**] <Insert color>.
3. SPD Devices: Blue.
4. Isolated-Ground Receptacles: [**Orange**] [**As specified above, with orange triangle on face**].

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 4. Connect devices to branch circuits using pigtails that are not less than **6 inches (152 mm)** in length.
 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 8. Tighten unused terminal screws on the device.
 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
 2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Dimmers:
1. Install dimmers within terms of their listing.
 2. Verify that dimmers used for fan-speed control are listed for that application.
 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

- I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Comply with Section 26 0553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with **[black]** **[white]** **[red]**-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:
 1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
 2. Test Instruments: Use instruments that comply with UL 1436.
 3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- D. Tests for Convenience Receptacles:
 1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- E. Test straight-blade **[convenience outlets in patient-care areas]** **[hospital-grade convenience outlets]** for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than **4 oz. (115 g)**.
- F. Wiring device will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

END OF SECTION 26 2726

SECTION 26 2813

FUSES

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. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Control circuits.
 - b. [Motor-control centers.**
 - c.]Panelboards.
 - d. Switchboards.
 - e. Enclosed controllers.
 - f. Enclosed switches.

- 2. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.
 - 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit [**in electronic format suitable for use in coordination software**] [**and**] [**in PDF format**].
 - 4. Coordination charts and tables and related data.
 - 5. Fuse size for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in [**Section 017700 "Closeout Procedures,"**] [**Section 017823 "Operation and Maintenance Data,"**] include the following:
 - 1. Ambient temperature adjustment information.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.

3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit **[in electronic format suitable for use in coordination software] [and] [in PDF format]**.
4. Coordination charts and tables and related data.

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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than **40 deg F (5 deg C)** or more than **100 deg F (38 deg C)**, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Bussmann; a division of Cooper Industries.
 2. Edison; a brand of Cooper Bussmann; a division of Cooper Industries.
 3. Littelfuse, Inc.
 4. Mersen.
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
 1. Type RK-1: **[250] [600]-V**, zero- to 600-A rating, 200 kAIC[, **time delay**].
 2. Type RK-5: **[250] [600]-V**, zero- to 600-A rating, 200 kAIC[, **time delay**].
 3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC[, **fast acting**] [, **time delay**].
 4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC[, **fast acting**] [, **time delay**].
 5. Type J: 600-V, zero- to 600-A rating, 200 kAIC[, **time delay**].
 6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC[, **time delay**].
 7. Type T: **[250-V, zero- to 1200-A] [600-V, zero- to 800-A]** rating, 200 kAIC[, **very fast acting**] [, **time delay**].
- 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. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70, "National Electrical Code."
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 - 2. Finish: Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
 - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Service Entrance: Class L, fast acting.
 - 2. Feeders: Class L, fast acting.
 - 3. Motor Branch Circuits: Class RK1, time delay.
 - 4. Large Motor Branch (601-4000 A): Class L, time delay.
 - 5. Power Electronics Circuits: Class J, high speed.
 - 6. Other Branch Circuits: Class RK1, time delay.
 - 7. Control Transformer Circuits: Class CC, time delay, control transformer duty.
 - 8. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by **[Architect] [Construction Manager] [Owner]**.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 2813

SECTION 26 2816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Receptacle switches.
 - 4. Shunt trip switches.
 - 5. Molded-case circuit breakers (MCCBs).
 - 6. Molded-case switches.
 - 7. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.
- B. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

1.7 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Fuse Pullers: Two for each size and type.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2010 m).

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with NFPA 70, "National Electrical Code."

2.2 FUSIBLE SWITCHES

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. **Eaton.**
 - 2. **General Electric Company.**
 - 3. **Siemens Industry, Inc.**
 - 4. **Schneider Electric; Square D.**
- B. Type HD, Heavy Duty:
 - 1. **[Single] [Double]** throw.
 - 2. **[Three] [six]** pole.
 - 3. **[240] [600]**-V ac.
 - 4. **[1200 A and smaller] [200 A and smaller]**.
 - 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate **[specified] [indicated]** fuses.
 - 6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 5. Auxiliary Contact Kit: **[One] [Two]** NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - **[24-V ac] [120-V ac] [208-V ac] [240-V ac] [6-V dc] [12-V dc] [24-V dc]**.
 - 6. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 7. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 8. Service-Rated Switches: Labeled for use as service equipment.

2.3 NONFUSIBLE SWITCHES

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. [Eaton.](#)
 2. [General Electric Company.](#)
 3. [Siemens Industry, Inc.](#)
 4. Schneider Electric; Square D.
- B. Type GD, General Duty, Three Pole, Single Throw, 240-V ac, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Three Pole, Single Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Six Pole, Single Throw, [240] [600]-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Type HD, Heavy Duty, Three Pole, Double Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- F. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 4. Auxiliary Contact Kit: [One] [Two] NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [24-V ac] [120-V ac] [208-V ac] [240-V ac] [6-V dc] [12-V dc] [24-V dc].
 5. Hookstick Handle: Allows use of a hookstick to operate the handle.
 6. Lugs: Mechanical type, suitable for number, size, and conductor material.
 7. Service-Rated Switches: Labeled for use as service equipment.

2.4 RECEPTACLE SWITCHES

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. [Eaton.](#)
 2. [General Electric Company.](#)
 3. [Siemens Industry, Inc.](#)
 4. Schneider Electric; Square D.
- B. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: [240] [600]-V ac, [30] [60] [100] <Insert amperage> A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads

to accommodate [specified] [indicated] fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

- C. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: [240] [600]-V ac, [30] [60] [100] <Insert amperage> A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.
- E. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).
- F. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 5. Auxiliary Contact Kit: [One] [Two] NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [24-V ac] [120-V ac] [208-V ac] [240-V ac] [6-V dc] [12-V dc] [24-V dc].
 - 6. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 7. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 8. Service-Rated Switches: Labeled for use as service equipment.

2.5 SHUNT TRIP SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. [Bussmann, an Eaton business.](#)
 - 2. Ferraz Shawmut, Inc.; Mersen.
 - 3. [Littelfuse, Inc.](#)
 - 4. Eaton Electric; Cutler-Hammer.
- B. General Requirements: Comply with [ASME A17.1,] UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.
- C. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: [240] [600]-V ac, [30] [60] [100] <Insert amperage> A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to accommodate [specified] [indicated] fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: [240] [600]-V ac, [30] [60] [100] <Insert amperage> A; UL 98 and NEMA KS 1; integral shunt trip mechanism;

horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

- E. Control Circuit: 120-V ac; obtained from **[integral control power transformer, with primary and secondary fuses,]** **<Insert source of control power>** with a control power **[transformer]** **[source]** of enough capacity to operate shunt trip, pilot, indicating and control devices.
- F. Accessories:
1. Oiltight key switch for key-to-test function.
 2. Oiltight **[red]** **[green]** **[white]** **[yellow]** ON pilot light.
 3. Isolated neutral lug; **[100]** **[200]** percent rating.
 4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 5. Form C alarm contacts that change state when switch is tripped.
 6. Three-pole, double-throw, fire-safety and alarm relay; **[120-V ac]** **[24-V dc]** coil voltage.
 7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.
 8. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 9. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 10. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 11. Auxiliary Contact Kit: **[One]** **[Two]** NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - **[24-V ac]** **[120-V ac]** **[208-V ac]** **[240-V ac]** **[6-V dc]** **[12-V dc]** **[24-V dc]**.
 12. Hookstick Handle: Allows use of a hookstick to operate the handle.
 13. Lugs: Mechanical type, suitable for number, size, and conductor material.
 14. Service-Rated Switches: Labeled for use as service equipment.

2.6 MOLDED-CASE CIRCUIT BREAKERS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. [Eaton.](#)
 2. [General Electric Company.](#)
 3. [Siemens Industry, Inc.](#)
 4. Schneider Electric; Square D.
- B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

- D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated.
- E. MCCBs shall be equipped with a device for locking in the isolated position.
- F. Lugs shall be suitable for 167 deg F (75 deg C) rated wire.
- G. Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I-squared t response.
- K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- L. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- M. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- N. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- O. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Ground-Fault Protection: Comply with UL 1053; **[integrally mounted, self-powered]** **[remote-mounted and powered]** type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 5. Communication Capability: **[Circuit-breaker-mounted]** **[Universal-mounted]** **[Integral]** **[Din-rail-mounted]** communication module with functions and features compatible with

- power monitoring and control system, specified in Section 26 0913 "Electrical Power Monitoring and Control."
6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 8. Auxiliary Contacts: **[One SPDT switch] [Two SPDT switches]** with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 9. Alarm Switch: One **[NO] [NC]** contact that operates only when circuit breaker has tripped.
 10. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 11. Zone-Selective Interlocking: Integral with **[electronic] [ground-fault]** trip unit; for interlocking ground-fault protection function.
 12. Electrical Operator: Provide remote control for on, off, and reset operations.
 13. Accessory Control Power Voltage: **[Integrally mounted, self-powered] [Remote mounted and powered]; [24-V ac] [120-V ac] [208-V ac] [240-V ac] [12-V dc] [24-V dc] [120-V dc]**.

2.7 MOLDED-CASE SWITCHES

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 1. [Eaton.](#)
 2. [General Electric Company.](#)
 3. [Siemens Industry, Inc.](#)
 4. Schneider Electric; Square D.
- B. Description: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.
- D. Features and Accessories:
 1. Standard frame sizes and number of poles.
 2. Lugs:
 - a. Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - b. Lugs shall be suitable for 167 deg F (**75 deg C**) rated wire.
 3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 6. Auxiliary Contacts: **[One SPDT switch] [Two SPDT switches]** with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
 7. Alarm Switch: One **[NO] [NC]** contact that operates only when switch has tripped.
 8. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.

9. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
10. Electrical Operator: Provide remote control for on, off, and reset operations.
11. Accessory Control Power Voltage: **[Integrally mounted, self-powered] [Remote mounted and powered]; [24-V ac] [120-V ac] [208-V ac] [240-V ac] [12-V dc] [24-V dc] [120-V dc]**.

2.8 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be **[finished with] [gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1)] [gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (NEMA 250 Types 3R, 12)] [a brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel)] [copper-free cast aluminum alloy (NEMA 250 Types 7, 9)]**.
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: The circuit-breaker operating handle shall be **[externally operable with the operating mechanism being an integral part of the box, not the cover] [directly operable through the front cover of the enclosure (NEMA 250 Type 1)] [directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R)] [externally operable with the operating mechanism being an integral part of the cover (NEMA 250 Types 7, 9)]**. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify [**Architect**] [**Construction Manager**] [**Owner**] no fewer than seven days in advance of proposed interruption of electric service.
 2. Indicate method of providing temporary electric service.
 3. Do not proceed with interruption of electric service without [**Architect's**] [**Construction Manager's**] [**Owner's**] written permission.
 4. Comply with NFPA 70E, "Standard for Electrical Safety in the Workplace."

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, [**Type 3R**] [**Type 4X**].
 3. [**Kitchen**] [**Wash-Down**] Areas: NEMA 250, [**Type 4X**], stainless steel.
 4. Other Wet or Damp, Indoor Locations: NEMA 250, [**Type 4**] <Insert type>.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 6. Hazardous Areas Indicated on Drawings: NEMA 250, [**Type 7**] [**Type 9**] <Insert type> [**with cover attached by Type 316 stainless steel bolts**].

3.4 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NFPA 70 and NECA 1.

3.5 IDENTIFICATION

- A. Comply with requirements in Section 26 0553 "Identification for Electrical Systems."
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 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 for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
 - i. Verify correct phase barrier installation.
 - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
- 2. Electrical Tests:
 - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate

values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

- d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

D. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
- b. Inspect physical and mechanical condition.
- c. Inspect anchorage, alignment, grounding, and clearances.
- d. Verify that the unit is clean.
- e. Operate the circuit breaker to ensure smooth operation.
- f. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- g. Inspect operating mechanism, contacts, and chutes in unsealed units.
- h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not

- available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
 - e. Determine the following by primary current injection:
 - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
 - f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
 - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
 - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
 - i. Verify operation of charging mechanism. Investigate units that do not function as designed.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 4. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

- E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.
 - 1. Test procedures used.
 - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 - 3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges[**as specified in Section 26 0573.16 "Coordination Studies."**] [**to values indicated on the Drawings.**] [**to values indicated in attached schedule.**]

END OF SECTION 26 2816

SECTION 26 2913.03

MANUAL AND MAGNETIC MOTOR CONTROLLERS

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. Manual motor controllers.
2. Enclosed full-voltage magnetic motor controllers.
3. Combination full-voltage magnetic motor controllers.
4. Enclosed reduced-voltage magnetic motor controllers.
5. Combination reduced-voltage magnetic motor controllers.
6. Multispeed magnetic motor controllers.
7. Enclosures.
8. Accessories.
9. Identification.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. NC: Normally closed.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SCPD: Short-circuit protective device.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each type of magnetic controller.

1. Include plans, elevations, sections, and mounting details.
2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Schedule: List the following for each enclosed controller:

1. Each installed magnetic controller type.
2. NRTL listing.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
6. For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.
 - a. Listing document proving Type 2 coordination.
7. For each series-rated combination state the listed integrated short-circuit current (withstand) rating of SCPD and OCPDs by an NRTL acceptable to authorities having jurisdiction.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.
 1. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:
 - a. Routine maintenance requirements for magnetic controllers and installed components.
 - b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - c. Manufacturer's written instructions for setting field-adjustable overload relays.
 - d. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
 - e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 50 W per controller.

1.9 FIELD CONDITIONS

- A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than 23 deg F (minus 5 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2010 m) for electromagnetic and manual devices.
 - 3. The effect of solar radiation is not significant.
 - 4. <Insert unusual service condition>.

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 use.
- B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.
- C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.

2.2 MANUAL MOTOR CONTROLLERS

- A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton.
 - b. General Electric Company.
 - c. Siemens Industry, Inc.
 - d. Square D; a brand of Schneider Electric.

2. Standard: Comply with NEMA ICS 2, general purpose, Class A.
 3. Configuration: **[Nonreversing]** **[Reversing]** **[Two speed]**.
 4. **[Flush]** **[Surface]** mounting.
 5. Red pilot light.
 6. Additional Nameplates: **[FORWARD and REVERSE for reversing switches]** **[HIGH and LOW for two-speed switches]** <Insert special markings>.
- B. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. **Eaton.**
 - b. **General Electric Company.**
 - c. **Siemens Industry, Inc.**
 - d. Square D; a brand of Schneider Electric.
 2. Configuration: **[Nonreversing]** **[Two speed]**.
 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
 4. Pilot Light: Red.
- C. Integral Horsepower Manual Controllers (IHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. **Eaton.**
 - b. **General Electric Company.**
 - c. **Siemens Industry, Inc.**
 - d. Square D; a brand of Schneider Electric.
 2. Configuration: **[Nonreversing]** **[Two speed]**.
 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
 4. Overload Relays: NEMA ICS 2, bimetallic class as scheduled on Drawings.
- 2.3 ENCLOSED FULL-VOLTAGE MAGNETIC MOTOR CONTROLLERS
- A. Description: Across-the-line start, electrically held, for nominal system voltage of 600-V ac and less.
- B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. **Eaton.**
 2. **General Electric Company.**

3. **Siemens Industry, Inc.**
 4. Square D; a brand of Schneider Electric.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: **[Nonreversing]** <Insert configuration>.
- E. Contactor Coils: Pressure-encapsulated type.
1. Operating Voltage: Manufacturer's standard, unless indicated.
- F. Control Power:
1. For on-board control power, obtain from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. Spare CPT Capacity as Indicated on Drawings: 50 VA.
- G. Overload Relays:
1. Thermal Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 20 tripping characteristic.
 - c. Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. **[Ambient compensated.]**
 - e. Automatic resetting.
 2. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor-running overload protection.
 - b. Sensors in each phase.
 - c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
- 2.4 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER
- A. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.
- B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. **Eaton.**
 2. **General Electric Company.**
 3. **Siemens Industry, Inc.**
 4. Square D; a brand of Schneider Electric.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.

- D. Configuration: Nonreversing.
- E. Contactor Coils: Pressure-encapsulated type.
 - 1. Operating Voltage: Manufacturer's standard, unless indicated.
- F. Control Power:
 - 1. For on-board control power, obtain from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. Spare CPT Capacity as Indicated on Drawings: 50 VA.
- G. Overload Relays:
 - 1. Thermal Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 20 tripping characteristic.
 - c. Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. **[Ambient compensated.]**
 - e. Automatic resetting.
 - 2. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor-running overload protection.
 - b. Sensors in each phase.
 - c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
- H. Fusible Disconnecting Means:
 - 1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
 - 2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- I. MCP Disconnecting Means:
 - 1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - 2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- J. MCCB Disconnecting Means:
 - 1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - 2. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 3. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.5 ENCLOSED REDUCED-VOLTAGE MAGNETIC MOTOR CONTROLLERS

- A. Description: Electrically held; closed-transition; adjustable time delay on transition, 600-V ac or less.
- B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. **Eaton.**
 2. **General Electric Company.**
 3. **Siemens Industry, Inc.**
 4. Square D; a brand of Schneider Electric.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration:
1. Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
 2. Part-Winding Controller: Separate START and RUN contactors, field-selectable for 1/2- or 2/3-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
 3. Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.
- E. Contactor Coils: Pressure-encapsulated type.
1. Operating Voltage: Manufacturer's standard, unless indicated.
- F. Control Power: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
1. Spare CPT Capacity: 50 VA.
- G. Overload Relays:
1. Thermal Overload Relays: Bimetallic type.
 - a. Inverse-time-current characteristic.
 - b. Class 20 tripping characteristic.
 - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. **[Ambient compensated].**
 - e. Automatic resetting.
 2. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor-running overload protection.
 - b. Sensors in each phase.
 - c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

2.6 COMBINATION REDUCED-VOLTAGE MOTOR CONTROLLERS

- A. Description: Factory-assembled, combination reduced-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, and SCPD and OCPD, in a single enclosure.
- B. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. **Eaton.**
 2. **General Electric Company.**
 3. **Siemens Industry, Inc.**
 4. Square D; a brand of Schneider Electric.
- C. Configuration:
1. Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
 2. Part-Winding Controller: Separate START and RUN contactors, field-selectable for 1/2- or 2/3-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
 3. Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.
- D. Contactor Coils: Pressure-encapsulated type.
1. Operating Voltage: Manufacturer's standard, unless indicated.
- E. Control Power: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
1. Spare CPT Capacity: 50 VA.
- F. Overload Relays:
1. Thermal Overload Relays: Bimetallic type.
 - a. Inverse-time-current characteristic.
 - b. Class 20 tripping characteristic.
 - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. **[Ambient compensated.]**
 - e. Automatic resetting.
 2. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor-running overload protection.
 - b. Sensors in each phase.
 - c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

G. Fusible Disconnecting Means:

1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

H. MCP Disconnecting Means:

1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

I. MCCB Disconnecting Means:

1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.7 ENCLOSURES

- A. Comply with NEMA 250, type designations as indicated on Drawings, complying with environmental conditions at installed location.
- B. The construction of the enclosures shall comply with NEMA ICS 6.
- C. Controllers in hazardous (classified) locations shall comply with UL 1203.

2.8 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
 1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.
 - a. Push Buttons: As indicated in the controller schedule.
 - b. Pilot Lights: As indicated in the controller schedule.
 2. Elapsed Time Meters: Heavy duty with digital readout in hours[; **nonresettable**] [; **resettable**].
 3. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.
- B. Motor protection relays shall be with solid-state sensing circuit and isolated output contacts for hardwired connections.
 1. Phase-failure.

2. Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.
 3. Under/overvoltage, operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.
- C. Breather assemblies, to maintain interior pressure and release condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- D. Space heaters, with NC auxiliary contacts, to mitigate condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- E. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

2.9 IDENTIFICATION

- A. Controller Nameplates: Laminated acrylic or melamine plastic signs, as described in Section 26 0553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.
- B. Arc-Flash Warning Labels:
1. **[Comply with requirements in Section 26 0573.19 "Arc-Flash Hazard Analysis." Produce a 3.5-by-5-inch (89-by-127-mm) self-adhesive equipment label for each work location included in the analysis.**
 - a. **The 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) **Flash protection boundary.**
 - 4) **Hazard risk category.**
 - 5) **Incident energy.**
 - 6) **Working distance.**
 - 7) **Engineering report number, revision number, and issue date.**
 - b. **Labels shall be machine printed, with no field-applied markings.]**

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION

- A. Comply with NECA 1, "Standard Practice for Good Workmanship in Electrical Construction."
- B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 26 0529 "Hangers and Supports for Electrical Systems" unless otherwise indicated.
- C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
 - 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with drawings and specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, and grounding.
 - d. Verify the unit is clean.
 - e. Inspect contactors:
 - 1) Verify mechanical operation.
 - 2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
 - f. Motor-Running Protection:
 - 1) Verify overload element rating is correct for its application.
 - 2) If motor-running protection is provided by fuses, verify correct fuse rating.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:

- 1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
3. Electrical Tests:
- a. For the contactor and circuit breaker, perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than those of this table or manufacturer's recommendations shall be investigated and corrected.
 - b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - c. Test motor protection devices according to manufacturer's published data.
 - d. Test circuit breakers as follows:
 - 1) Operate the circuit breaker to ensure smooth operation.
 - 2) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.
 - e. Perform operational tests by initiating control devices.
- C. Motor controller will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- 3.5 SYSTEM FUNCTION TESTS
- A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.
 1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
 2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
 3. Verify the correct operation of sensing devices, alarms, and indicating devices.
 - B. Motor controller will be considered defective if it does not pass the system function tests and inspections.

- C. Prepare test and inspection reports.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain motor controllers.

END OF SECTION 26 2913.03

SECTION 26 2923

VARIABLE-FREQUENCY MOTOR CONTROLLERS

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 separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

- A. CE: Conformance Europeene (European Compliance).
- B. CPT: Control power transformer.
- C. DDC: Direct digital control.
- D. EMI: Electromagnetic interference.
- E. LED: Light-emitting diode.
- F. NC: Normally closed.
- G. NO: Normally open.
- H. OCPD: Overcurrent protective device.
- I. PID: Control action, proportional plus integral plus derivative.
- J. RFI: Radio-frequency interference.
- K. VFC: Variable-frequency motor controller.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFC indicated.
 - 1. Include dimensions and finishes for VFCs.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each VFC indicated.

1. Include mounting and attachment 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Required working clearances and required area above and around VFCs.
 2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
 3. Show support locations, type of support, and weight on each support.
 4. Indicate field measurements.
- B. Qualification Data: For testing agency.
- C. Product Certificates: For each VFC from manufacturer.
- D. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker trip settings.
 - b. Manufacturer's written instructions for setting field-adjustable overload relays.
 - c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
 - e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 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. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
 - 4. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace VFCs 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 MANUFACTURERS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB.
 - 2. Danfoss Inc.
 - 3. Eaton.
 - 4. Toshiba International Corp.
 - 5. Schneider Electric USA, Inc.
 - 6. Yaskawa.

2.2 SYSTEM DESCRIPTION

- A. General Requirements for VFCs:

1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- B. Application: **[Constant torque] [and] [variable torque]**.
- C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
 2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
 3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- E. Output Rating: Three phase; 10 to **[60 Hz, with voltage proportional to frequency throughout voltage range] [66 Hz, with torque constant as speed changes]**; maximum voltage equals input voltage.
- F. Unit Operating Requirements:
1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
 2. Input AC Voltage Unbalance: Not exceeding 5percent.
 3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
 4. Minimum Efficiency: 96 percent at 60 Hz, full load.
 5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
 6. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
 7. Ambient Temperature Rating: Not less than **32 deg F (0 deg C)** and not exceeding **104 deg F (40 deg C)**.
 8. Humidity Rating: Less than 95 percent (noncondensing).
 9. Altitude Rating: Not exceeding **3300 feet (1000 m)**.
 10. Vibration Withstand: Comply with NEMA ICS 61800-2.
 11. Overload Capability: **[1.1] [1.5]** times the base load current for 60 seconds; minimum of 1.3 times the base load current for two seconds.
 12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
 13. Speed Regulation: Plus or minus 5 percent.
 14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
 15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Inverter Logic: Microprocessor based, **[16] [32]** bit, isolated from all power circuits.
- H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: **[Electrical]** **[Pneumatic]**.
- I. Internal Adjustability Capabilities:
 1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: **[0.1 to 999.9]** <Insert range> seconds.
 4. Deceleration: **[0.1 to 999.9]** <Insert range> seconds.
 5. Current Limit: 30 to minimum of 150 percent of maximum rating.
 - J. Self-Protection and Reliability Features:
 1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
 2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
 3. Under- and overvoltage trips.
 4. Inverter overcurrent trips.
 5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
 6. Critical frequency rejection, with three selectable, adjustable deadbands.
 7. Instantaneous line-to-line and line-to-ground overcurrent trips.
 8. Loss-of-phase protection.
 9. Reverse-phase protection.
 10. Short-circuit protection.
 11. Motor-overtemperature fault.
 12. Input power fuses dedicated for VFC drive unit.
 - K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
 - L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
 - M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
 - N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
 - O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
 - P. Integral Input Disconnecting Means and OCPD: UL 489, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.
 1. Disconnect Rating: Not less than 115 percent of VFC input current rating.

2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.

2.3 CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicators displaying the following conditions:
1. Power on.
 2. Run.
 3. Overvoltage.
 4. Line fault.
 5. Overcurrent.
 6. External fault.
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
 2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
 - a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
- C. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
 2. Running log of total power versus time.
 3. Total run time.
 4. Fault log, maintaining last four faults with time and date stamp for each.
- D. Indicating Devices: Digital display[**and additional readout devices as required,**] mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
1. Output frequency (Hz).
 2. Motor speed (rpm).
 3. Motor status (running, stop, fault).
 4. Motor current (amperes).
 5. Motor torque (percent).
 6. Fault or alarming status (code).
 7. PID feedback signal (percent).
 8. DC-link voltage (V dc).
 9. Set point frequency (Hz).
 10. Motor output voltage (V ac).
- E. Control Signal Interfaces:
1. Electric Input Signal Interface:

- a. A minimum of two programmable analog inputs: [0- to 10-V dc] [4- to 20-mA dc] [Operator-selectable "x"- to "y"-mA dc].
 - b. A minimum of six multifunction programmable digital inputs.
2. Pneumatic Input Signal Interface: 3 to 15 psig (20 to 104 kPa).
 3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
 - a. 0- to 10-V dc.
 - b. 4- to 20-mA dc.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 4. Output Signal Interface: A minimum of one programmable analog output signal(s) (4- to 20-mA dc), which can be configured for any of the following:
 - a. Output frequency (Hz).
 - b. Output current (load).
 - c. DC-link voltage (V dc).
 - d. Motor torque (percent).
 - e. Motor speed (rpm).
 - f. Set point frequency (Hz).
 5. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - a. Motor running.
 - b. Set point speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high- or low-speed limits reached.
- F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
1. Number of Loops: One.
- G. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.
1. Hardwired Points:
 - a. Monitoring: On-off status.
 - b. Control: On-off operation.
 2. Communication Interface: Comply with ASHRAE 135. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.

2.4 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations. As a minimum, provide a 5 percent input line reactor, integral to the VFC.
- B. Output Filtering: <Insert requirements>.
- C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for [Category C2] <Insert category>.
- D. EMI/RFI Filtering: <Insert requirements>.

2.5 BYPASS SYSTEMS

- A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
- B. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic-control system feedback.
- C. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller[; **with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode**].
 - 1. Bypass Contactor: Load-break, IEC-rated contactor.
 - 2. Output Isolating Contactor: Non-load-break, IEC-rated contactor.
 - 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
- D. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller[; **with input isolating switch and barrier**] arranged to isolate the power converter input and output and permit safe testing[**and troubleshooting**] of the power converter, both energized and de-energized, while motor is operating in bypass mode.
 - 1. Bypass Contactor: Load-break, IEC-rated contactor.
 - 2. Input and Output Isolating Contactors: Non-load-break, IEC-rated contactors.
 - 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
- E. Bypass Contactor Configuration: [Full-voltage (across-the-line)] [Reduced-voltage (autotransformer)] <Insert type> type.

1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.
3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
4. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors**].
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: **[50] [100] [200]** VA.
6. Overload Relays: NEMA ICS 2.
 - a. Melting-Alloy Overload Relays:
 - 1) Inverse-time-current characteristic.
 - 2) Class 20 tripping characteristic.
 - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - b. Bimetallic Overload Relays:
 - 1) Inverse-time-current characteristic.
 - 2) **[Class 10] [Class 20] [Class 30]** tripping characteristic.
 - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - 4) Ambient compensated.
 - 5) Automatic resetting.
 - c. Solid-State Overload Relays:
 - 1) Switch or dial selectable for motor-running overload protection.
 - 2) Sensors in each phase.
 - 3) Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - 4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
 - 5) Analog communication module.
 - d. **[NC] [NO]** isolated overload alarm contact.
 - e. External overload, reset push button.

2.6 OPTIONAL FEATURES

- A. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications when overload protection activates.
 - 1. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
- B. Damper control circuit with end-of-travel feedback capability.
- C. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.
- D. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.
- E. Firefighter's Override (Smoke Purge) Input: On a remote contact closure from **[the firefighter's control station] [smoke-control fan controller] <Insert location>**, this password-protected input:
 - 1. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).
 - 2. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.
 - 3. Causes display of override mode on the VFC display.
 - 4. Reset VFC to normal operation on removal of override signal automatically.
- F. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.
- G. Remote digital operator kit.
- H. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer **[and a notebook computer]**.

2.7 ENCLOSURES

- A. VFC Enclosures: UL 50 labeled, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Outdoor Locations: Type 3R.
 - 3. **[Kitchen] [Wash-Down] Areas**: Type 4X, stainless steel.
 - 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
- B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.8 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons: **[Covered]** **[Lockable]** **[Shielded]** **[Unguarded]**.
 2. Pilot Lights: Push to test.
 3. Selector Switches: **[Rotary]** **<Insert description>** type.
 4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- B. **[NC]** **[NO]** **[Reversible NC/NO]** bypass contactor auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable **[pneumatic]** **[solid-state]** time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- E. Supplemental Digital Meters:
1. Elapsed-time meter.
 2. Kilowatt meter.
 3. Kilowatt-hour meter.
- F. Breather and drain assemblies, to maintain interior pressure and release condensation in UL50, **[Type 4]** **[Type 4X]** **[Type 12]** enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, **[Type 3R]** **[Type 4X]** **[Type 12]** **<Insert type>** enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- H. Cooling Fan and Exhaust System: For NEMA 250, **[Type 1]** **[Type 12]**; UL 508 component recognized: Supply fan, with **[composite]** **[stainless-steel]** intake and exhaust grills **[and filters]**; 120-V ac; obtained from integral CPT.
- I. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- 2.9 SOURCE QUALITY CONTROL
- A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
1. Test each VFC while connected to **[its specified motor]** **[a motor that is comparable to that for which the VFC is rated]**.
 2. Verification of Performance: Rate VFCs according to operation of functions and features specified.
- B. VFCs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, <insert **Project-specific conditions**,> and other conditions affecting performance of the Work.
- B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than **79 inches (2000 mm)** above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 26 0529 "Hangers and Supports for Electrical Systems."
- B. Floor-Mounting Controllers: Install VFCs on **4-inch (100-mm)** nominal thickness concrete base. Comply with requirements for concrete base specified in [**Section 03 3000 "Cast-in-Place Concrete."**] [**Section 03 3053 "Miscellaneous Cast-in-Place Concrete."**]
 - 1. 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.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 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.
- C. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than **79 inches (2000 mm)** above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
 - 1. Curbs and roof penetrations are specified in Section 07 7200 "Roof Accessories."
 - 2. Structural-steel channels are specified in Section 26 0529 "Hangers and Supports for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

- E. Install fuses in control circuits if not factory installed. Comply with requirements in Section 26 2813 "Fuses."
- F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.
- G. Comply with NECA 1, "Standard Practice for Good Workmanship in Electrical Construction."

3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices[**and facility's central-control system**]. Comply with requirements in Section 26 0523 "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
 - 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.
- D. When local disconnect is used at the motor, provide a normally open auxiliary contact in local disconnect wired to the VFC control to stop the VFC when disconnect is "OFF."

3.4 CONDUIT CONNECTIONS

- A. Install all conduits into bottom of VFC enclosure. Input conductors must be in separate conduit from output conductors.

3.5 IDENTIFICATION

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each VFC with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify **[Architect]** **[Construction Manager]** **[Owner]** before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify **[Architect]** **[Construction Manager]** **[Owner]** before increasing settings.

D. **[Set the taps on reduced-voltage autotransformer controllers.]**

E. Set field-adjustable circuit-breaker trip ranges **[as specified in Section 26 0573.16 "Coordination Studies."]**

- F. Set field-adjustable pressure switches.

3.9 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 DEMONSTRATION

- A. **[Engage a factory-authorized service representative to train] [Train]** Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 26 2923

SECTION 26 5119
LED INTERIOR LIGHTING

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 the following types of LED luminaires:

1. Cylinder.
2. Downlight.
3. Highbay, linear.
4. Linear industrial.
5. Lowbay.
6. Parking garage.
7. Recessed linear.
8. Strip light.
9. Surface mount, linear.
10. Surface mount, nonlinear.
11. Suspended, linear.
12. Suspended, nonlinear.
13. Materials.
14. Finishes.
15. Luminaire support.

- B. Related Requirements:

1. Section 26 0923"Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 26 0926"Lighting Control Panelboards" for panelboards used for lighting control.
3. Section 26 0933"Central Dimming Controls" or Section 26 0936 "Modular Dimming Controls" for architectural dimming systems and for fluorescent dimming controls with dimming ballasts specified in interior lighting Sections.
4. Section 26 0943.16"Addressable-Luminaire Lighting Controls" and Section 26 0943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.

- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
 - 6. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire 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.
- C. **[Sustainable Design Submittals:]**
 - 1. **[Product Data: Indicating luminaire is certified by [ENERGY STAR] [Design Lights Consortium].]**

- D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing laboratory providing photometric data for luminaires.
- B. Product Certificates: For each type of luminaire.
- C. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

- D. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 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. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- D. **[Mockups: For interior luminaires in room or module mockups, complete with power and control connections.**
 - 1. **Obtain Architect's approval of luminaires in mockups before starting installations.**
 - 2. **Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.**
 - 3. **Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.**
 - 4. **Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.]**

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE 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. Standards:
1. ENERGY STAR certified.
 2. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
 3. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
 4. UL Listing: Listed for damp location.
 5. Recessed luminaires shall comply with NEMA LE 4.
 6. User Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with ANSI C81.61.
- C. CRI of **[minimum] [65] [70] [80]**. CCT of **[2700 K] [3000 K] [4100 K]**.
- D. Rated lamp life of 50,000 hours to L70.
- E. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- F. Internal driver.
- G. Nominal Operating Voltage: **[120 V ac] [277 V ac]**.
1. Lens Thickness: At least **0.125 inch (3.175 mm)** minimum unless otherwise indicated.
- H. Housings:
1. **[Extruded-aluminum] <Insert option>** housing and heat sink.
 2. **[Clear] <Insert color> [anodized] [powder-coat] [painted]** finish.

2.2 CYLINDER

- A. Minimum **[250] [575] [1000] <Insert number>** lumens. Minimum allowable efficacy of 80 lumens per watt.
- B. With integral mounting provisions.

2.3 DOWNLIGHT

- A. Minimum **[1,000] <Insert number>** lumens. Minimum allowable efficacy of 80 lumens per watt.

- B. Universal mounting bracket.
 - C. Integral junction box with conduit fittings.
 - D. Optics:
 - 1. **[Fixed]** **[Adjustable]** lens.
 - 2. **[Spot]** **[Medium]** **[Wide]** light distribution.
- 2.4 HIGHBAY, LINEAR
- A. Minimum **[10,000]** **<Insert number>** lumens. Minimum allowable efficacy of 80 lumens per watt.
- 2.5 HIGHBAY, NONLINEAR
- A. Minimum **[10,000]** **<Insert number>** lumens. Minimum allowable efficacy of 80 lumens per watt.
 - B. Universal mounting bracket.
 - C. Integral junction box with conduit fittings.
- 2.6 LINEAR INDUSTRIAL
- A. Minimum **[5,000]** **<Insert number>** lumens. Minimum allowable efficacy of 80 lumens per watt.
 - B. Housing and heat sink rated to the following:
 - 1. Class 1, Division 2 Group(s) **[A]** **[B]** **[C]** **[and]** **[D]**.
 - 2. NEMA 4X.
 - 3. IP 54.
 - 4. IP 66.
 - 5. Marine and wet locations.
 - 6. CSA C22.2 No 137.
- 2.7 LOWBAY
- A. Minimum **[5,000]** **[10,000]** **<Insert number>** lumens. Minimum allowable efficacy of 80 lumens per watt.
 - B. Universal mounting bracket.
- 2.8 PARKING GARAGE
- A. Minimum **[2,000]** **<Insert number>** lumens. Minimum allowable efficacy of 75 lumens per watt.
 - B. Low-profile housing and heat sink.
 - C. Fully gasketed and sealed. **[IP 65 rated.]**
 - D. Stainless-steel latches.
 - E. Integral pressure equalizer.

2.9 RECESSED LINEAR

- A. Minimum [1,500] [2,000] [3,000] <Insert number> lumens. Minimum allowable efficacy of 85 lumens per watt.
- B. Integral junction box with conduit fittings.

2.10 STRIP LIGHT

- A. Minimum [750] <Insert number> lumens. Minimum allowable efficacy of [75] [80] lumens per watt.
- B. Integral junction box with conduit fittings.

2.11 SURFACE MOUNT, LINEAR

- A. Minimum [750] <Insert number> lumens. Minimum allowable efficacy of [75] [80] lumens per watt.
- B. Integral junction box with conduit fittings.

2.12 SURFACE MOUNT, NONLINEAR

- A. Minimum [750] <Insert number> lumens. Minimum allowable efficacy of [75] [80] lumens per watt.
- B. Integral junction box with conduit fittings.

2.13 SUSPENDED, LINEAR

- A. Minimum [1,500] [2,000] [3,000] <Insert number> lumens. Minimum allowable efficacy of 85 lumens per watt.

2.14 SUSPENDED, NONLINEAR

- A. Minimum [1,500] [2,000] [3,000] <Insert number> lumens. Minimum allowable efficacy of 85 lumens per watt.
- B. Integral junction box with conduit fittings.

2.15 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. **[Tempered Fresnel glass] [prismatic glass] [diffuse glass] [clear glass] [prismatic acrylic] [clear, UV-stabilized acrylic]**
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least **0.125 inch (3.175 mm)** minimum unless otherwise indicated.

D. Housings:

1. **[Extruded-aluminum] <Insert material>** housing and heat sink.
2. **[Clear] <Insert color> [anodized] [powder-coat] [painted]** finish.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI for all luminaires.

2.16 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.17 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: **1/2-inch (13-mm)** steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, **12 gage (2.68 mm)**.
- D. Rod Hangers: **3/16-inch (5-mm)** minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

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 of the Work.

- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1, "Standard Practice for Good Workmanship in Electrical Construction."
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaire Support:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- F. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.
- G. Ceiling-Mounted Luminaire Support:
 - 1. Ceiling mount with two **5/32-inch- (4-mm-)** diameter aircraft cable supports adjustable to **120 inches (6 m)** in length.
 - 2. Ceiling mount with [**pendant mount**] [**four-point pendant mount**] with **5/32-inch- (4-mm-)** diameter aircraft cable supports adjustable to **120 inches (6 m)** in length.
 - 3. Ceiling mount with hook mount.
- H. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than **48 inches (1200 mm)**, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.

3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and **[tubing or rod] [wire support]** for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

J. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 26 0943.16 "Addressable-Luminaire Lighting Controls."

B. Comply with requirements for startup specified in Section 26 0943.23 "Relay-Based Lighting Controls."

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 26 5119

SECTION 26 5213

EMERGENCY AND EXIT LIGHTING

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. Exit signs.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Fixture: See "Luminaire" Paragraph.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - 1. Include data on features, accessories, and finishes.
 - 2. Include physical description of the unit and dimensions.
 - 3. Battery and charger for light units.
 - 4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing laboratory providing photometric data for luminaires.
- B. Product Test Reports: For each luminaire for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

- A. Warranty Period: Two year(s) from date of Substantial Completion.
 - 1.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- 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. NRTL Compliance: Fabricate and label exit signs to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.
- E. Lamp Base: Comply with ANSI C81.61.

- F. Bulb Shape: Complying with ANSI C79.1.
- G. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.
 - 1. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 2. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - 3. Charger: Fully automatic, solid-state, constant-current type.
 - 4. Housing: NEMA 250, Type 1 enclosure
 - 5. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 6. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.2 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.

2.3 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1, "Standard Practice for Good Workmanship in Electrical Construction."
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Ceiling Grid Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
 - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

END OF SECTION 26 5219

SECTION 26 5619
LED EXTERIOR LIGHTING

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. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.

B. Related Requirements:

- 1. Section 26 0923"Lighting Control Devices" for automatic control of lighting, including time switches and photoelectric relays

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

- 1. Arrange in order of luminaire designation.
- 2. Include data on features, accessories, and finishes.
- 3. Include physical description and dimensions of luminaire.
- 4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
- 5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.

- a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.

6. Wiring diagrams for power, control, and signal wiring.

- B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing laboratory providing photometric data for luminaires.
- B. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Source quality-control reports.
- D. Sample warranty.

1.6 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- D. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.8 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.9 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

- a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
2. Warranty Period: 2 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE 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. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. UL Compliance: Comply with UL 1598 and listed for wet location.
- E. Internal driver.
- F. Source Limitations: Obtain luminaires from single source from a single manufacturer.
- G. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- C. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage and coating.
 - c. CCT and CRI for all luminaires.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1, "Standard Practice for Good Workmanship in Electrical Construction."
- B. Wiring Method: Install cables in raceways. Conceal raceways and cables.
- C. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.
- D. Coordinate layout and installation of luminaires with other construction.
- E. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables" and 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- C. Luminaire will be considered defective if it does not pass tests and inspections.
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 5619

SECTION 27 0528

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. The Contractor shall provide all equipment, materials, labor, and services necessary to complete or perfect all parts of the technology systems cable pathways and to ensure that they are in compliance with requirements stated or reasonably inferred by the Contract Documents, this Specification, and the Construction Drawings.

1.2 SCOPE OF WORK

- A. This section includes minimum requirements for the following horizontal and backbone technology systems pathways as they relate to providing interior pathways not already provided by the project:
1. Cable Tray
 2. Cable supports
 3. Sleeves – non-fire-rated wall
 4. Sleeves – fire-rated wall
 5. Fire stop

1.3 QUALITY ASSURANCE

- A. All pathways and associated 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's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Materials and work specified herein shall comply with the applicable requirements of the most recent version of the following:
1. ANSI/TIA/EIA-526, Standard Test Procedures for Fiber Optic Systems.
 2. TIA-526-7 (Ofstp-7), Measurement of Optical Fiber Loss of Installed Single-Mode Fiber Cable Plant.
 3. TIA-526-14-B (Ofstp-14), Optical Power Loss Measurements of Multimode Fiber Cable Plant.
 4. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises.
 5. ANSI/TIA -568-C.1, Commercial Building Telecommunications Cabling Standard.
 6. ANSI/TIA -568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
 7. ANSI/TIA -568-C.3, Optical Fiber Cabling and Components Standard.
 8. ANSI/TIA -568-C.4, Broadband Coaxial Cabling and Components Standard.
 9. ANSI/TIA -569-C, Telecommunications Pathways and Spaces.

10. ANSI/TIA -606-B, Administration Standard for Commercial Telecommunications Infrastructure.
11. ANSI/TIA -607-B, Commercial Building Grounding (Earthing) And Bonding Requirements for Telecommunications.
12. ANSI/TIA -758-B, Customer-Owned Outside Plant Telecommunications Infrastructure Standard.
13. Information and Communications Technology Authority (ICTA) Regulations.
14. Building Industry Consulting Services International (BICSI) Telecommunications Distribution Methods Manual.
15. Underwriters Laboratory (UL) Or Equivalent.
16. National Electrical Manufacturers Association.
17. National Fire Protection Association (NFPA) 70 - National Electrical Code.
18. ISO/IEC 11801, Information Technology - Generic Cabling for Customer Premises.
19. Goucher College Cabling and Telecommunications Standards.

1.4 SUBMITTALS

- A. The Contractor shall provide product data sheets for all products that are part of this specification section.
- B. As part of the bid proposal, the Bidder shall submit a complete and detailed bill-of-materials listing quantity, part number, manufacturer, part description, unit price, and extended price for each item the Contractor proposes to use in this project, including all products listed in this section. At the end of the bill of material, the Bidder shall list a Total Material Cost, Total Labor Cost, Total Other Cost (printing, permits, storage, etc.), and Overall Total Cost for the project.

PART 2 – PRODUCTS

2.1 CABLE TRAY

- A. Any new tray supporting horizontal and backbone cable in the hallways shall be basket-type tray.
- B. Tray supporting horizontal and backbone cable in the telecommunications rooms shall be basket-type tray or ladder rack.
- C. Tray in hallways shall be a minimum of 12-inches wide by 4-inches high, as shown on the drawings.
- D. Tray in TRs, cable tray or ladder rack shall be a minimum of 12-inches wide by 2-inches deep, as shown on the drawings.
- E. Tray shall include connecting and support hardware to suit installation, including but not limited to runway supports, wall angle support brackets, adjustable splice kits, tee splice kits, splice extension clamp kits, vertical bend kits, corner support kits, and grounding strap kits.

F. Acceptable Manufacturers:

1. Cablofil
2. Chatsworth Products, Inc.
3. WBT
4. Cooper B-Line
5. Other approved equal

2.2 CABLE SUPPORTS

A. Cable supports shall either be J-hook type supports or sling-type supports.

B. All supports shall be UL listed and comply with NEC and TIA requirements for structured cabling.

C. If J-hook type:

1. Shall have galvanized finish.
2. Shall be corrosion resistant.
3. Shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables.
4. Shall have flared edges to prevent damage while installing cables.
5. Shall be rated to support both Category 6 copper and optical fiber cabling.
6. Shall have an open top with rolled edges.
7. Shall have a minimum of a 2-inch diameter loop.

D. If sling-type:

1. Shall be suitable for plenum air handling spaces.
2. Shall be constructed from steel and woven laminate or plastic.
3. Shall have a static load limit of 100 lbs.
4. Shall be rated to support both Category 6 copper and optical fiber cabling.
5. Shall support approximately 250 Category 6 cables.

E. Acceptable manufacturers:

1. Erico
2. Arlington Industries
3. Other approved equal

2.3 SLEEVES – NON-FIRE-RATED WALL

A. Where desired pathway has not penetrated a wall to facilitate cabling between spaces and cable routing path, and the wall is not a fire rated wall, the Contractor shall provide appropriate sized metallic sleeve to appropriately penetrate the area.

B. The sleeve shall be sized using generally accepted cabling principles, using a 40% fill ratio.

2.4 SLEEVES – FIRE-RATED WALL

- A. Where desired pathway has not penetrated a wall to facilitate cabling between spaces and cable routing path, and the wall is a fire rated wall, the Contractor shall provide a sleeve that has the intumescent fire stop material as a manufactured part of the sleeve.
- B. Shall be UL listed.
- C. Shall provide ease of cable penetration and re-penetration.
- D. Acceptable manufacturers:
 - 1. Hilti Speed Sleeve
 - 2. Other approved equal

2.5 FIRE STOP

- A. Fire stop shall be rated to match the rating of the space in which it is used.
- B. Fire stop shall meet the project requirements as may be specified elsewhere in the architectural specifications.
- C. Acceptable manufacturers:
 - 1. 3M
 - 2. Hilti
 - 3. Nelson
 - 4. Other approved equal

PART 3 – EXECUTION

3.1 CABLE TRAY

- A. Install cable tray in hallways to appropriately facilitate the routing of horizontal cables transitioning to riser chases, etc. and telecom room.
- B. Install cable tray in telecommunications room to appropriately facilitate the routing of horizontal and backbone cables to termination points within the room.
- C. Exact location of tray in hallway and TR shall be verified with designer prior to installation.

3.2 CABLE SUPPORTS

- A. Wherever cable tray, conduit, or other designated telecommunications cabling pathway is not present, Contractor shall provide cable hangers a maximum of 60 inches on center.
- B. Ceiling ties and rods shall not be used to hang cable or cable supports without the approval of the Owner.
- C. Load hangers as recommended by the manufacturer. Provide hangers side by side on a common bracket where cable quantities require.

- D. Do not install cables loose above lock-in type, drywall or plaster ceilings.
- E. Cables shall be installed at least 3 inches above the ceiling and shall not touch the ceiling.

3.3 SLEEVES – NON-FIRE RATED WALL

- A. Appropriately anchor the sleeve.
- B. Appropriately fire stop the sleeve after installation.

3.4 SLEEVES – FIRE RATED WALL

- A. Install sleeve per manufacturer's instructions.

3.5 FIRE STOP

- A. The Contractor shall fire stop all sleeves, conduit openings, cable tray openings, etc. with an appropriate fire stop material rated for the particular application after the cable installation is complete. This shall include all telecommunications cabling openings, whether they have been used or not.

END OF SECTION 27 0528

SECTION 27 1100

COMMUNICATIONS EQUIPMENT ROOMS

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. The Contractor shall provide all equipment, materials, labor, and services necessary to complete or perfect all parts of the telecommunications rooms and spaces that are part of this bid package, and shall ensure that they are in compliance with requirements stated or reasonably inferred by this Specification and the Construction Drawings.

1.2 SCOPE OF WORK

- A. This section includes minimum requirements for the following equipment and cable installations in communications equipment rooms.
 - 1. Floor-mounted rack
 - 2. Horizontal cable management
 - 3. Vertical cable management
 - 4. Copper cable patch panels
 - 5. Copper cable patch cords
 - 6. Optical fiber housing
 - 7. Optical fiber patch cords
 - 8. Grounding wire
 - 9. Fire stop
- B. There is only one (1) new Telecommunications Room (TR) for this project located on the Lower Level of the new Interfaith Center.
- C. Backbone cables have been designed to connect the new TR to the existing telecom space in the Basement of the existing Chapel as shown on the drawings.
- D. Horizontal cables from all Levels shall route to the new TR on the Lower Level as shown on the drawings.

1.3 QUALITY ASSURANCE

- A. All equipment installed in communications equipment rooms shall be done in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Specification shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacturer indicated. The equipment specified is based on the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified, and shall be subject to approval prior to procurement and installation.
- B. Materials and work specified herein shall comply with the applicable requirements of the most recent version of the following:
 - 1. ANSI/TIA/EIA-526, Standard Test Procedures for Fiber Optic Systems.

2. TIA-526-7 (Ofstp-7), Measurement of Optical Fiber Loss of Installed Single-Mode Fiber Cable Plant.
3. TIA-526-14-B (Ofstp-14), Optical Power Loss Measurements of Multimode Fiber Cable Plant.
4. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises.
5. ANSI/TIA -568-C.1, Commercial Building Telecommunications Cabling Standard.
6. ANSI/TIA -568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
7. ANSI/TIA -568-C.3, Optical Fiber Cabling and Components Standard.
8. ANSI/TIA -568-C.4, Broadband Coaxial Cabling and Components Standard.
9. ANSI/TIA -569-C, Telecommunications Pathways and Spaces.
10. ANSI/TIA -606-B, Administration Standard for Commercial Telecommunications Infrastructure.
11. ANSI/TIA -607-B, Commercial Building Grounding (Earthing) And Bonding Requirements for Telecommunications.
12. ANSI/TIA -758-B, Customer-Owned Outside Plant Telecommunications Infrastructure Standard.
13. Information and Communications Technology Authority (ICTA) Regulations.
14. Building Industry Consulting Services International (BICSI) Telecommunications Distribution Methods Manual.
15. Underwriters Laboratory (UL) Or Equivalent.
16. National Electrical Manufacturers Association.
17. National Fire Protection Association (NFPA) 70 - National Electrical Code.
18. ISO/IEC 11801, Information Technology - Generic Cabling for Customer Premises.
19. Goucher College Cabling and Telecommunications Standards.

1.4 SUBMITTALS

- A. As part of the bid proposal, the Bidder shall submit a complete and detailed bill-of-materials listing quantity, part number, manufacturer, part description, unit price, and extended price for each item the Contractor proposes to use in this project, including all products listed in this section. At the end of the bill of material, the Bidder shall list a Total Material Cost, Total Labor Cost, Total Other Cost (printing, permits, storage, etc.), and Overall Total Cost for the project.
- B. When requested by the Construction Manager, the Contractor shall submit manufacturers' data sheets (cut sheets) for all proposed equipment in this specification section.

PART 2 – PRODUCTS

2.1 FLOOR-MOUNTED RACK

- A. The floor-mounted rack shall measure approximately 7 feet high by 6.5 inches deep with 19 inch rails.
- B. The floor-mounted rack shall have mounting hole spacing of repetitive 1-1/4 inch and 1/2 inch spacing according to the ANSI/CEA-310-E Cabinets, Racks, Panels, and Associated Equipment standard.
- C. The floor-mounted rack shall provide a minimum of 44 RMU (rack-mount units).

D. Acceptable Manufacturer:

1. Ortronics Mighty Mo 20

2.2 HORIZONTAL CABLE MANAGEMENT

A. Horizontal cable management shall be provided for any new patch panels.

B. Horizontal cable management shall be 2 rack units.

C. Horizontal cable management shall have a swing cover that can open from either top or bottom.

D. Acceptable Manufacturers:

1. Ortronics Mighty Mo 6

2.3 VERTICAL CABLE MANAGEMENT

A. Vertical cable management shall be provided with all new racks.

B. The vertical managers shall be 6 inches wide on each end of the rack.

C. Vertical cable management shall be cage type with swing door or have latches.

D. Vertical cable management shall be able to appropriately attach to the Floor-Mounted Rack.

E. Acceptable Manufacturers:

1. Ortronics Mighty Mo 20

2.4 COPPER CABLE PATCH PANELS

A. Category 6 patch panels shall meet or exceed the following specifications:

1. Category 6 standards.
2. 48-ports.
3. T568B wired.
4. Have sufficient ports to provide at least 15% growth.
5. Have a paired punch down sequence to allow the pair twists to be within ½-inch of the termination.
6. Rack-mounted.
7. UL listed.
8. Made of rolled edge black anodized aluminum construction.
9. From the same manufacturer as the other connectivity products (jacks, faceplates, etc.) used for this project.

B. Category 6A patch panels shall meet or exceed the following specifications:

1. Category 6A standards.
2. 48-ports.
3. T568B wired.
4. Have sufficient ports to provide at least 15% growth.

5. Have a paired punch down sequence to allow the pair twists to be within ½-inch of the termination.
6. Rack-mounted.
7. UL listed.
8. Made of rolled edge black anodized aluminum construction.
9. From the same manufacturer as the other connectivity products (jacks, faceplates, etc.) used for this project.

C. Acceptable Manufacturers:

1. Ortronics Clarity 6 and Clarity 6A

2.5 COPPER CABLE PATCH CORDS

- A. Patch cords for the TRs shall be 4-pair, factory-terminated, double-ended, 8-position to 8-position, center tuned modular, stranded conductors, Category 6 or Category 6A.
- B. Category 6 and 6A patch cords shall be of the same manufacturer as Category 6 and 6A cable.
- C. Patch cords for cables supporting data other than wireless access points shall be blue Category 6.
- D. Patch cords for cables supporting wireless access points shall be green Category 6A.
- E. Acceptable Manufacturers:
 1. Ortronics Clarity 6 and 6A

2.6 OPTICAL FIBER HOUSING

- A. Optical fiber housings shall meet or exceed the following specifications:
 1. Provide a minimum of 24 ports of capacity.
 2. Shall be rack-mounted.
 3. Shall support both singlemode and multimode optical fiber cables.
- B. Shall be populated with LC duplex adapter modules.
- C. Acceptable Manufacturer:
 1. Corning CCH

2.7 OPTICAL FIBER PATCH CORDS

- A. Optical fiber patch cords shall be factory-terminated, double-ended, 2-strand singlemode cordage with LC connectors on each end.
- B. Acceptable Manufacturers:
 1. Corning

2.8 GROUNDING WIRE

- A. Shall be a minimum #6 AWG stranded copper.
- B. Shall have green plastic insulation.

2.9 FIRE STOP

- A. Fire stop shall be rated to match the rating of the space in which it is used.
- B. Fire stop shall meet the project requirements as may be specified elsewhere in the architectural specifications.
- C. Acceptable manufacturers:
 - 1. 3M
 - 2. Hilti
 - 3. Nelson
 - 4. Other approved equal

PART 3 – EXECUTION

3.1 FLOOR-MOUNTED RACKS

- A. In the new TR, there shall be one (1) rack installed.
- B. Once the rack location has been verified by the Owner, the rack shall be appropriately leveled and anchored to the floor.
- C. The rack shall be appropriately grounded.
- D. The rack shall be further supported by the installation of cable tray per the drawings.
 - 1. The Contractor shall confirm the exact location of ladder rack prior to its installation.

3.2 HORIZONTAL CABLE MANAGEMENT

- A. There shall be one (1) 2U horizontal cable manager installed above and below each 48-port patch panel installed in a rack.
- B. An equal amount of 2U horizontal managers shall be provided and installed in the rack to be above and below each switch (coordinate exact location of these with Goucher IT).

3.3 VERTICAL CABLE MANAGEMENT HARDWARE

- A. One (1) 6-inch vertical cable manager shall be installed on each side of the rack.

3.4 COPPER CABLE PATCH PANELS

- A. Patch panels shall be installed in each equipment cabinet for the purposes of terminating all Category 6 and Category 6A horizontal copper cable.

- B. The Contractor shall install enough Category 6 patch panels to provide termination of all Category 6 cabling, plus approximately 15%.
- C. The Contractor shall install enough Category 6A patch panels to provide termination of all Category 6A cabling, plus approximately 15%.
- D. The copper cable patch panels shall be installed below the optical fiber housing (the exact location of the patch panels in the rack shall be confirmed with the owner or owner's representative prior to their installation).
- E. All patch panels shall be appropriately labeled with an owner-accepted labeling scheme.

3.5 COPPER PATCH CORDS

- A. Contractor shall provide one (1) patch cord for each terminated patch panel port.
- B. For bidding purposes, half the patch cords shall be five (5) feet long; half the patch cords shall be ten (10) feet long. Prior to purchasing any patch cords, the exact length and quantity shall be verified with Goucher IT.
- C. Contractor shall not install patch cords in the TRs. Rather, they shall be delivered to Goucher IT for installation.

3.6 OPTICAL FIBER HOUSING

- A. Install the optical fiber housing at the top of the rack.
- B. Appropriately label all ports of the patch panels with Owner accepted labeling scheme.
- C. Install blank adapter panels in all positions not used at time of installation for fiber terminations.

3.7 OPTICAL FIBER PATCH CORDS

- A. Contractor shall provide four (4) singlemode optical fiber patch cords.
- B. Optical fiber patch cords shall be one (1) meter in length.
- C. Contractor shall not install optical fiber patch cords in the TRs. Rather, they shall be delivered to Goucher IT for installation.

3.8 GROUNDING AND BONDING

- A. Bond metallic equipment racks, conduits, cable tray, ladder racks to the ground bar.
- B. All connectors and clamps shall be mechanical type made of silicon bronze.
- C. Terminals shall be solderless, copper long-barrel NEMA two bolt compression-type.
- D. Bond the shield of shielded cable to the ground bar in communications rooms and spaces.

3.9 FIRE STOP

- A. The Contractor shall fire stop all sleeves, conduit openings, cable tray openings, etc. with an appropriate fire stop material rated for the particular application after the cable installation is complete. This shall include all telecommunications cabling openings, whether they have been used or not.
- B. Installation, testing, and labeling of fire stop locations shall meet the overall project requirements.

3.10 LABELING

- A. All cables, termination panels, patch panels, blocks, etc. are to be labeled using a machine printed label. Handwritten labels shall not be used.
- B. No cables or termination panels shall be permanently labeled until an approved labeling scheme is provided to the Contractor by the Owner or its representative.
- C. Note all labeling information on the as-built drawings.

3.11 RECORD DOCUMENTATION

- A. Prior to final acceptance of the work, the Contractor shall submit two (2) sets of record documentation.
- B. Record documentation shall include:
 - 1. TR plan and elevation drawings indicating block fields, rack locations, patch panel labels, cable labels, routing, etc.
 - 2. Drawings shall be provided in both hard copy and in electronic format. The electronic format shall be the most recent version of AutoCAD.

END OF SECTION 27 1100

SECTION 27 1300

COMMUNICATIONS BACKBONE CABLING

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. The Contractor shall provide all equipment, materials, labor, and services necessary to complete or perfect all parts of the optical fiber backbone cabling system, and to ensure that it is in compliance with requirements stated or reasonably inferred by this Specification and the Construction Drawings.

1.2 SCOPE OF WORK

- A. The backbone cabling is that portion of the telecommunications cabling system that connects the Main Telecommunications Room to the other Telecommunications Rooms (TR) throughout the building. Backbone cabling consists of the actual transmission media, mechanical terminations, splice enclosures, intermediate and main cross-connects, and any patch cords or jumpers used for backbone-to-backbone connections.
- B. This section includes minimum requirements for the following:
 - 1. Copper tie cable
 - 2. Optical fiber tie cable
 - 3. Optical fiber connectors
- C. There is only one (1) new Telecommunications Room (TR) for this project located on the Lower Level of the new Interfaith Center.
- D. Backbone cables have been designed to connect the new TR to the existing telecom space in the Basement of the existing Chapel as shown on the drawings.
- E. Horizontal cables from all Levels shall route to the new TR on the Lower Level as shown on the drawings.

1.3 QUALITY ASSURANCE

- A. All materials 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's Representative. Equipment and materials shall be of the quality and manufacturer indicated. The equipment specified is based upon the acceptable manufacturers listed.
- B. Materials and work specified herein shall comply with the applicable requirements of the most recent version of the following:
 - 1. ANSI/TIA/EIA-526, Standard Test Procedures for Fiber Optic Systems.
 - 2. TIA-526-7 (Ofstp-7), Measurement of Optical Fiber Loss of Installed Single-Mode Fiber Cable Plant.
 - 3. TIA-526-14-B (Ofstp-14), Optical Power Loss Measurements of Multimode Fiber Cable Plant.

4. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises.
5. ANSI/TIA -568-C.1, Commercial Building Telecommunications Cabling Standard.
6. ANSI/TIA -568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
7. ANSI/TIA -568-C.3, Optical Fiber Cabling and Components Standard.
8. ANSI/TIA -568-C.4, Broadband Coaxial Cabling and Components Standard.
9. ANSI/TIA -569-C, Telecommunications Pathways and Spaces.
10. ANSI/TIA -606-B, Administration Standard for Commercial Telecommunications Infrastructure.
11. ANSI/TIA -607-B, Commercial Building Grounding (Earthing) And Bonding Requirements for Telecommunications.
12. ANSI/TIA -758-B, Customer-Owned Outside Plant Telecommunications Infrastructure Standard.
13. Information and Communications Technology Authority (ICTA) Regulations.
14. Building Industry Consulting Services International (BICSI) Telecommunications Distribution Methods Manual.
15. Underwriters Laboratory (UL) Or Equivalent.
16. National Electrical Manufacturers Association.
17. National Fire Protection Association (NFPA) 70 - National Electrical Code.
18. ISO/IEC 11801, Information Technology - Generic Cabling for Customer Premises.
19. Goucher College Cabling and Telecommunications Standards.

1.4 SUBMITTALS

- A. The Contractor shall submit manufacturers' data sheets (cut sheets) for proposed cable types, termination equipment, cable management or support hardware, and labeling material.
- B. The Contractor shall submit manufacturers' instructions for storage, handling, protection, examination, preparation, operation, and installation of all products. Include any application conditions or limitations of use stipulated by any product testing agency.
- C. The Contractor shall submit all applicable Material Safety Data Sheets.
- D. As part of the bid proposal, the Bidder shall submit a complete and detailed bill-of-materials listing quantity, part number, manufacturer, part description, unit price, and extended price for each item the Contractor proposes to use in this project, including all products listed in this section. At the end of the bill of material, the Bidder shall list a Total Material Cost, Total Labor Cost, Total Other Cost (printing, permits, storage, etc.), and Overall Total Cost for the project.

PART 2 – PRODUCTS

2.1 COPPER TIE CABLE

- A. Backbone copper tie cable shall be 25-pair Category 3 copper cable as shown on the drawings.
- B. The cable shall consist of a core of 24 AWG solid annealed bare copper conductors, color coded in accordance with telephone industry standards.

- C. Conductors shall be twisted to form pairs. Shall be CMP rated.
- D. Acceptable Manufacturers:
 - 1. General
 - 2. Superior Essex
 - 3. Other approved equal

2.2 OPTICAL FIBER TIE CABLE

- A. Shall be 6-strand OS2 singlemode optical fiber cable.
- B. Shall be tight buffered OS2 optical fiber cables designed for installation in plenum environments.
- C. Shall be OFNP rated.
- D. Shall be armored or installed in flexible duct (especially in crawl space).
- E. Shall have the following characteristics:
 - 1. Shall be class IVa Dispersion-Unshifted single-mode optical fibers complying with ANSI/EIA/TIA-492BAAA with fiber counts as indicated on drawings.
 - 2. The zero dispersion wavelength shall be between 1300 nm and 1324 nm. The ANSI/EIA/TIA-455-168 maximum value of the dispersion slope shall be no greater than 0.093 ps/km-nm². Dispersion measurements shall be made in accordance with ANSI/EIA/TIA-455-169 or ANSI/EIA/TIA-455-175.
 - 3. The nominal core diameter shall be 8.3 μm to 9.0 μm at 1300 nm when measured in accordance with ANSI/EIA/TIA-455-164 or ANSI/EIA/TIA-455-167.
 - 4. Transmission Characteristics:
 - a) Maximum attenuation dB/Km @ 1310/1550nm: 1.0
 - b) The cutoff wavelength shall be less than 1279 nm when measured in accordance with ANSI/EIA/TIA-455-170
- F. Acceptable Manufacturers:
 - 1. Berk-Tek
 - 2. Corning
 - 3. Superior Essex
 - 4. Other approved equal

2.3 OPTICAL FIBER CONNECTORS

- A. Each strand of optical fiber cable shall be terminated with an LC connector.
- B. All optical fiber connectors shall meet ANSI/EIA/TIA standards.
- C. The connector shall have an optical axial pull strength of 2.2 N at 0 degree angle and an optical off axial pull strength of 2.2 N at a 90 degree angle, with a maximum 0.5 dB increase in attenuation for both tests when tested in accordance with ANSI/EIA/TIA standards.

- D. The connectors shall be fusion-spliced, factory polished pigtails or field-terminated fiber connectors.
- E. The connectors shall be mounted in a rack mountable connector housing.
- F. Typical loss shall not exceed 0.2 dB with a maximum loss of 0.4 dB per connector
- G. Durability shall not be less than 0.2 dB change over 100 re-matings.
- H. Acceptable Manufacturers:
 - 1. Corning
 - 2. Ortronics

PART 3 – EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the schedule.
- B. 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 premises when no longer required.
- C. No equipment shall be hidden or covered up prior to inspection by the Owner or Owner's Representative. All work that is determined to be unsatisfactory shall be corrected immediately.
- D. All work shall be installed level and plumb, parallel and perpendicular to other building systems and components.
- E. The Contractor shall fire stop all penetrations made, used or provided for telecommunications installation in all fire-rated walls. Contractor shall also plug all telecommunications conduits in all telecommunications man-holes, and all conduit entries into buildings.
- F. Storage and security of material and equipment shall be the responsibility of the Contractor.
- G. All cables shall be neatly "dressed" in telecommunications rooms.
- H. Shall be of the size and type specified on the drawings.
- I. All cables shall have been manufactured within 12 months of purchase date.
- J. Contractor shall adhere to all manufacturers' requirements regarding pulling tension, allowable lubricants, and bending radius.
- K. Contractor shall be responsible for verifying that pathways are ready for occupancy prior to cable placement.
- L. Contractor shall assume responsibility for any difficulties or damage to the cable during placement.

- M. Pulling tensions shall not exceed those recommended by the cable manufacturer. Use a line tension meter during cable pull to provide accurate measurement of the force exerted on a cable as it is installed.
- N. Cable shall be watched and inspected for sheath defects, as it is payed off the reel. Pulling operation shall be stopped and Owner or Owner's Representative shall be notified if a defect or any other irregularity is found.
- O. Placement shall conform to industry standards with regard to anchoring, cable support and separation from other facilities.
- P. Cables and innerduct shall not sag or droop, but should be installed so as to maintain a flat plane with smooth transitions from one level or direction to another.

3.2 COPPER TIE CABLE

- A. The copper tie cable shall originate in the new Telecom Room on the Lower Level of the new building and extend to the Basement level of the existing chapel as shown on the drawings.
- B. On each end, the cable shall be terminated on wall-mounted 110-type blocks.
- C. Especially in the crawl space, the cable shall be in flexible duct supported by "J-hooks" a maximum of 60-inch centers.
- D. If conduit or tray is not available elsewhere, the cable shall be supported by "J-hooks" supported from building structure on a maximum of 60-inch centers.
- E. All cables shall be tested, labeled, and documented.

3.3 OPTICAL FIBER TIE CABLE

- A. The optical fiber tie cable shall originate in the new Telecom Room on the Lower Level of the new building and extend to the Basement level of the existing chapel as shown on the drawings.
- B. In the new TR, the cable shall be terminated with LC connectors installed in rack-mounted fiber housing.
- C. In the existing telecom space in the chapel, the cable shall be terminated with LC connectors installed in wall-mounted fiber housing (existing may have space).
- D. Especially in the crawl space, the cable shall be in flexible duct supported by "J-hooks" a maximum of 60-inch centers.
- E. If conduit or tray is not available elsewhere, the cable shall be supported by "J-hooks" supported from building structure on a maximum of 60-inch centers.
- F. Polarization for entire system shall be maintained as described in ANSI/EIA/TIA-568.
- G. A service loop of 15' shall be maintained at all cable ends.
- H. Vertical runs of fiber optic cable shall be secured a minimum of every 48 inches.

- I. All optical fiber cables shall be tested, labeled, and documented.

3.4 OPTICAL FIBER CONNECTORS

- A. Adhere to all manufacturer installation guidelines.
- B. Optical fiber pigtails shall be fusion-spliced to the optical fiber cable.
- C. Connectors shall be installed with less than 0.75 dB of attenuation per mated pair.

3.5 COPPER BACKBONE TESTING

- A. One hundred percent of the backbone copper cable pairs shall be tested for opens, shorts, polarity reversals, transpositions, and the presence of AC voltage.
- B. The Contractor shall examine open and shorted pairs to determine if the termination has been done properly. If so, the Contractor shall tag bad pairs at both ends, and make note on the as-built documentation. If the problem is found to be due to termination error, the contractor shall correct the error and retest the pair(s) in question.
- C. If any single copper backbone cable (under one sheath) contains more than one percent (1%) bad pairs, the Contractor shall remove and replace the cable at its expense.

3.6 OPTICAL FIBER BACKBONE CABLE TESTING

- A. Testing procedures shall be in accordance with the following:
 1. ANSI/TIA/EIA-568-A
 2. ANSI/TIA/EIA-568-B.1
 3. ANSI/TIA/EIA-526-7, Method B
 4. ANSI/TIA/EIA-526-14, Method B
 5. Proposed TSB-140 Tier Two Fiber Certification, Draft 2
- B. Preparation
 1. Properly clean all connectors, adapters, and jumpers prior to testing.
 2. Ensure that the testing jumpers are of the same fiber core diameter and connector type as the fibers to be tested.
 3. The power meter shall be properly calibrated prior to testing. Contractor shall provide written confirmation of the calibration, with the power meter serial number, to the Owner, if requested. If this documentation is not available upon request, the Contractor shall re-test all optical fiber cables after documented calibration of the power meter is accomplished.
- C. Testing
 1. All single optical fibers shall be tested at both 1310 nm and 1550 nm wavelengths for end-to-end insertion loss and bi-directional.
 2. Ensure that the power meter and light source are set to the same wavelength prior to testing each fiber.

3.7 TEST RESULTS

A. Copper Tie Cable:

1. The Contractor shall test all backbone copper cables and submit test result information in an electronic format. Acceptable formats are the most recent version of Microsoft Word or Microsoft Excel.

B. Fiber Optic Tie Cable:

1. The Contractor shall test all fiber optic cables and submit all fiber test result data in an electronic format and provide one (1) hard copy of the test results showing graphically, the entire length of the fiber.
2. Reports shall show circuit ID, cursor marks, total attenuation, date of installation and test used.
3. The Contractor shall submit (1) copy of software capable of viewing the electronic test result files.

3.8 LABELING

A. All tie cables are to be labeled using a machine printed label at each end of the cable at approximately 12 inches of the termination point, as well as in each TR.

B. Handwritten labels shall not be used.

C. All wiring blocks, connector panels, or other termination points shall be labeled with the cable identifier, as well as the pair or conductor identifier.

D. The labels shall denote, at a minimum, the starting and end points of the cable, as well as a unique cable identifier.

E. No cables shall be permanently labeled until an approved labeling scheme is provided to the Contractor by the Owner or its representative.

F. Note all labeling information on the as-built drawings.

3.9 RECORD DOCUMENTATION

A. Prior to final acceptance of the work, the Contractor shall submit two (2) sets of record documentation.

B. Record documentation shall include:

1. Floor plan and TR room drawings indicating all riser cable termination panels, cabling, routing, and labeling.
2. Drawings shall be provided in both hard copy and in electronic format. The electronic format shall be the most recent version of AutoCAD.

END OF SECTION 27 1300

SECTION 27 1500

COMMUNICATIONS HORIZONTAL CABLING

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. The Contractor shall provide all equipment, materials, labor, and services necessary to complete or perfect all parts of the horizontal cabling system, and to ensure that it is in compliance with requirements stated or reasonably inferred by the this specification, and the construction drawings.

1.2 SCOPE OF WORK

- A. The horizontal cabling is that portion of the telecommunication cabling system that extends from the work area telecommunications outlet for a variety of devices to the telecommunications room. In addition to satisfying all current telecommunications requirements, the horizontal cabling system shall facilitate ongoing maintenance and relocation requirements, as well as readily accommodating any future equipment and service changes. The horizontal cabling includes the horizontal cables, the mechanically terminated jacks/inserts and the faceplates that the jacks/inserts snap into, in the work area.
- B. This section includes minimum requirements for the following:
1. Unshielded twisted-pair (UTP) copper cables
 2. Jacks
 3. Faceplates
 4. Testing equipment
 5. Labels
- C. There is only one (1) new Telecommunications Room (TR) for this project located on the Lower Level of the new Interfaith Center.
- D. Backbone cables have been designed to connect the new TR to the existing telecom space in the Basement of the existing Chapel as shown on the drawings.
- E. Horizontal cables from all Levels shall route to the new TR on the Lower Level as shown on the drawings.

1.3 QUALITY ASSURANCE

- A. All materials shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Specification shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacturer indicated. The equipment specified is based upon the acceptable manufacturers listed.
- B. The Contractor shall strictly adhere to all Category 6 installation practices when installing unshielded twisted-pair cabling.
- C. Materials and work specified herein shall comply with the applicable requirements of the most recent version of the following:

1. ANSI/TIA/EIA-526, Standard Test Procedures for Fiber Optic Systems.
2. TIA-526-7 (Ofstp-7), Measurement of Optical Fiber Loss of Installed Single-Mode Fiber Cable Plant.
3. TIA-526-14-B (Ofstp-14), Optical Power Loss Measurements of Multimode Fiber Cable Plant.
4. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises.
5. ANSI/TIA -568-C.1, Commercial Building Telecommunications Cabling Standard.
6. ANSI/TIA -568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
7. ANSI/TIA -568-C.3, Optical Fiber Cabling and Components Standard.
8. ANSI/TIA -568-C.4, Broadband Coaxial Cabling and Components Standard.
9. ANSI/TIA -569-C, Telecommunications Pathways and Spaces.
10. ANSI/TIA -606-B, Administration Standard for Commercial Telecommunications Infrastructure.
11. ANSI/TIA -607-B, Commercial Building Grounding (Earthing) And Bonding Requirements for Telecommunications.
12. ANSI/TIA -758-B, Customer-Owned Outside Plant Telecommunications Infrastructure Standard.
13. Information and Communications Technology Authority (ICTA) Regulations.
14. Building Industry Consulting Services International (BICSI) Telecommunications Distribution Methods Manual.
15. Underwriters Laboratory (UL) Or Equivalent.
16. National Electrical Manufacturers Association.
17. National Fire Protection Association (NFPA) 70 - National Electrical Code.
18. ISO/IEC 11801, Information Technology - Generic Cabling for Customer Premises.
19. Goucher College Cabling and Telecommunications Standards.

1.4 SUBMITTALS

- A. As part of the bid proposal, the Bidder shall submit a letter of approval or other certification from the manufacturer indicating successful completion of the pre-qualification requirements for the installation of the proposed products.
- B. As part of the bid proposal, the Bidder shall submit a complete and detailed bill-of-materials listing quantity, part number, manufacturer, part description, unit price, and extended price for each item the Contractor proposes to use in this project, including all products listed in this section. At the end of the bill of material, the Bidder shall list a Total Material Cost, Total Labor Cost, Total Other Cost (printing, permits, storage, etc.), and Overall Total Cost for the project.
- C. Prior to any products being ordered, the Contractor shall submit manufacturers' data sheets (cut sheets) for proposed cable types, termination equipment, and cable management or support hardware.
- D. One month prior to completion of the cabling installation, the Contractor shall submit a complete test plan per ANSI/TIA/EIA 568 standards.
- E. Within 2 weeks following testing, the Contractor shall submit complete test results.

PART 2 – PRODUCTS

2.1 UTP COPPER CABLE

- A. Except for cables supporting wireless access points, all horizontal cable shall be Category 6, 4-pair, 100 ohm, 23 AWG, unshielded twisted pair (UTP) copper cable.

1. Cables supporting wireless access points shall be Category 6A.

- B. All horizontal UTP copper cable shall be plenum rated.

- C. All Category 6 cable for data shall be blue.

- D. All Category 6A cable for wireless shall be green.

- E. Category 6 cables shall meet the following tested at 250 MHz:

1.	Return Loss (RL):	15.2 dB
2.	Near-End Crosstalk (NEXT):	35.8 dB
3.	Power Sum NEXT (PSNEXT):	33.8 dB
4.	Insertion Loss (IL):	45.3 dB / 100m
5.	Attenuation to Crosstalk (ACR):	-9.4 dB / 100m
6.	Power Sum ACR (PSACR):	-11.4 dB / 100m
7.	Attenuation to Crosstalk Ratio Far-end (ACRF):	17.8 dB / 100m
8.	Power Sum ACRF (PSACRF):	14.8 dB / 100m
9.	Longitudinal Conversion Loss / Transverse Conversion Loss (LCL / TCL)	23.0 dB

- F. Category 6A cables shall meet the following tested at 500 MHz:

1.	Return Loss (RL):	15.2 dB
2.	Near-End Crosstalk (NEXT):	35.8 dB
3.	Power Sum NEXT (PSNEXT):	33.8 dB
4.	Insertion Loss (IL):	45.3 dB / 100m
5.	Attenuation to Crosstalk (ACR):	-9.4 dB / 100m
6.	Power Sum ACR (PSACR):	-11.4 dB / 100m
7.	Attenuation to Crosstalk Ratio Far-end (ACRF):	17.8 dB / 100m
8.	Power Sum ACRF (PSACRF):	14.8 dB / 100m
9.	Longitudinal Conversion Loss / Transverse Conversion Loss (LCL / TCL)	23.0 dB

- G. Acceptable Manufacturers:

1. Superior-Essex Series 77 (Category 6); Superior-Essex 10Gain (Category 6A)

2.2 JACKS

- A. All jacks for Category 6 cables shall be Category 6, 8-position, 8-conductor modular jacks, with IDC terminals.

- B. All jacks for Category 6A cables shall be Category 6A, 8-position, 8-conductor modular jacks, with IDC terminals.

- C. Pin/Pair assignment shall be in accordance with T568B.

- D. All Category 6 jacks for data shall be blue.
- E. All Category 6A jacks for wireless shall be green.
- F. Acceptable Manufacturers:
 - 1. Ortronics Clarity 6 TracJack; Ortronics Clarity 6A TracJack

2.3 FACEPLATES

- A. Faceplates shall be constructed from high impact thermo-plastic, with recessed label fields.
- B. Faceplates shall have the ability to mount within a single-gang wall box.
- C. Faceplates shall have a designation strip holder.
- D. Faceplates shall be UL listed.
- E. Faceplates shall be white.
- F. Faceplates shall be the size designated on the drawings.
- G. Blanks shall be inserted to cover empty jack locations.
- H. Acceptable Manufacturers:
 - 1. Ortronics TracJack

2.4 TEST EQUIPMENT

- A. Use an approved testing device for all horizontal cables.
- B. Acceptable manufacturers:
 - 1. Fluke
 - 2. Agilent
 - 3. Other approved equal.

2.5 LABELS

- A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
- B. Shall be pre-printed or laser printed type.
- C. Where used for cable marking, a label with a vinyl substrate and white printing area and a clear "tail" that self laminates the printed area when wrapped around the cable shall be provided. The label color shall be different than that of the cable to which it is attached.
- D. Where insert type labels are used, provide clear plastic cover over label.
- E. Acceptable Manufacturers:
 - 1. Ideal
 - 2. Brother P-Touch

3. W.H. Brady
4. Other approved equal

PART 3 – EXECUTION

3.1 CABLE INSTALLATION – GENERAL

- A. All horizontal cabling shall be installed per the “T” set of drawings.
- B. All wiring concealed in walls or soffits shall be installed in metal conduits.
- C. All cabling above ceilings shall be plenum-rated and installed in a conduit, basket tray, or cable hangers.
- D. If cable tray or conduit is not available, cables above accessible ceilings shall be supported 4 to 5 feet on center from cable hangers attached to the building structure.
- E. The Contractor shall adhere to all ANSI/TIA/EIA and manufacturers’ installation instructions for the placement and termination of the cable. This includes without limitation pulling tension, bend radius, jacket stripping, and pair untwisting.
- F. It is the intent that the maximum cable distance between the work-area outlet and the termination in the telecommunications room shall be 90 meters. If any horizontal cables are longer than 90 meters, these shall be brought to the immediate attention of the Owner or Owner’s Representative.
- G. Cables shall have no physical defects such as cuts, tears or bulges in the outer jacket. Cables with defects shall be replaced.
- H. The Contractor shall install cable in a neat and workmanlike manner. All cables shall be neatly bundled and tied in rooms. Leave sufficient cable for 90° sweeps at all vertical drops.
- I. At each device location the cables shall be terminated on the appropriate insert mounted in an appropriate faceplate.
- J. When placing cable, the Contractor shall maintain the following clearances from sources of electro-mechanical interference (EMI).
 1. Power cable - 6 inches
 2. Fluorescent Lights - 12 inches
 3. Transformers - 36 inches
- K. Cables with jackets that are chaffed or burned exposing internal conductor insulation, or that have any bare copper exposed (“shiners”) shall be replaced.
- L. The Contractor shall fire stop all penetrations it makes through fire barriers.
- M. All cables shall be neatly “dressed” using Velcro straps.

3.2 UTP COPPER CABLE

- A. Prior to installing any Category 6A cables (as well as pathways supporting Category 6A cables) for wireless access points, the Contractor shall contact Goucher College IT regarding a heat map survey they (Goucher College) will be performing.

- B. The results of the heat map survey will likely alter the locations of the Category 6A cables that are shown on the drawings. The Contractor shall review the heat map survey with Goucher IT and their representatives and shall then install the Category 6A cables (and associated pathways where required) per the results of the survey and subsequent review meeting.
- C. Following the installation of the Category 6A cables supporting wireless (and the subsequent termination, testing, and labeling of those cables), the Contractor shall notify Goucher IT, who will provide the Contractor with pre-programmed wireless access points.
- D. Upon receiving the wireless access points, the Contractor shall install the access points at the determined locations and cross-connect them at the device and in the telecommunications rooms (this will be done after Goucher has installed their data switches)
- E. Once wireless access points have been installed and cross-connected, the Contractor, with Goucher IT, will walk the building and confirm that the wireless access points are providing the appropriate coverage throughout.
- F. If it is determined that there are “dead spots”, Goucher College will re-do the heat mapping and provide updated locations. The Contractor will then re-locate or install additional cables and access points to provide appropriate coverage.

3.3 JACKS AND FACEPLATES

- A. All Category 6 cables shall be terminated with 8P8C modular jacks that snap into a faceplate mounted on a wall outlet box or surface raceway.
- B. All Category 6A cables (for wireless) shall be terminated with 8P8C modular plug.
- C. Outlet boxes shall be secured to the building with mechanical fasteners. Adhesive fasteners are not allowed.
- D. Any unused openings in the faceplate shall be filled with blank inserts.
- E. Termination shall be made so that pin/pair assignments are in accordance with T568B.

3.4 TESTING PROCEDURES

- A. All cables and termination hardware shall be tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-B.
- B. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.
- C. All cables shall be tested in accordance with this document, the ANSI/TIA/EIA standards, the manufacturers' procedures, and best industry practice. If any of these are in conflict, the Contractor shall bring any discrepancies to the attention of the project team for clarification and resolution.

3.5 UTP COPPER CABLE TESTING

- A. Testing shall conform to current industry standards for performance of 100-ohm Category 6 and Category 6A UTP cable.
- B. Testing shall be accomplished using a UL certified tester capable of performing a full complement of Category 6 and Category 6A tests.
- C. Testing shall be performed after cables have been terminated and permanently labeled. The permanent cable address shall be used for all testing identification.
- D. Any cable failing the prescribed certification testing shall be removed and replaced at the Contractor's expense.
- E. The Contractor shall provide Category 6 and Category 6A channel test results on all pairs of cable, including but not limited to cable length, wire map, near-end cross-talk (NEXT), Power Sum NEXT, attenuation to cross-talk ratio (ACR), Power Sum ACR, equal level far-end cross-talk (ELFEXT), Power Sum ELFEXT, and Return Loss.
- F. Results shall be provided in an electronic format.

3.6 TEST RESULTS

- A. The Contractor shall test all cables and submit all horizontal cable test result data in electronic format, with the resulting file formatted with one test result per 8.5-inch x 11-inch page.

3.7 LABELING

- A. All horizontal cables are to be labeled using a machine printed label at each end of the cable at approximately 12 inches of the termination point.
- B. Handwritten labels shall not be used.
- C. All faceplates and jacks shall be labeled with a unique identifier.
- D. No cables or termination panels shall be permanently labeled until an approved labeling scheme is provided to the Contractor by the Owner or its representative.
- E. Note all labeling information on the as-built drawings.

3.8 RECORD DOCUMENTATION

- A. Prior to final acceptance of the work, the Contractor shall submit two (2) sets of record documentation.
- B. Record documentation shall include:
 - 1. Floor plan drawings indicating device locations, cable routing, and label.
 - 2. Drawings shall be provided in both hard copy and in electronic format. The electronic format shall be the most recent version of AutoCAD.

END OF SECTION 27 1500

SECTION 27 4100

AUDIO-VISUAL SYSTEMS

PART 1 – GENERAL

1.1 SCOPE OF WORK

- A. This section includes the minimum requirements for the AV systems and equipment for the Great Room and Dining Room and Hillel Lounge.

1.2 QUALITY ASSURANCE

- A. All equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Specification shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based on the acceptable manufacturers listed. Where "approved equal", or "Basis for Design" is stated, the bidder is free to propose alternatives. However, alternative equipment shall be equivalent in all *material* ways to that of the equipment specified, and subject to prior approval.
- B. Materials and work specified herein shall comply with the applicable requirements of:
 - 1. Underwriters Laboratory or equivalent
 - 2. Federal Communications Commission
 - 3. National Electric Code (NEC)
 - 4. Federal, State, and Local regulations
- C. Contractor shall employ and provide at least one InfoComm certified installer for all on-site installation work.
- D. Comply with current governing codes, ordinances and regulations, and all other applicable codes.
- E. Installer Qualifications: The Contractor performing the Work of this Section must, within the last five (5) consecutive years, have successfully completed in a timely fashion at least three (3) projects similar in scope and type to the required work for this Section.
- F. The Contractor performing the Work of this Section may demonstrate compliance with the above qualification requirements by demonstrating that it is certified or authorized as an installer by a manufacturer designated as acceptable in these Specifications. A copy of such manufacturer certification or authorizations must be submitted, or verified in writing by the manufacturer.
- G. Any discrepancies that arise between this specification and the associated drawings, or between the AV design documents and field conditions shall be immediately brought to the attention of the Owner and the designer for reconciliation. No requests for additional charges will be allowed for work performed without this reconciliation process where any discrepancies exist.
- H. Where discrepancies in the construction documents or uncertainties in terms of the intent of the documents exist, contractor shall execute a written Request for Information and forward it to the design team. Contractor shall not be relieved of its obligation under these documents due to its failure to request clarification or additional information in a timely manner.

- I. Basis for Design – As part of this design some equipment is listed as “Basis for Design”. This means that the specifications of the listed equipment were used in the development of the design.
 - 1. Contractor may provide alternative equipment that meets the specifications of the Basis for Design equipment in all material ways. Substitutions should be indicated at bid time and listed on the bidder’s bill of materials required under 1.04.A.
 - 2. If a Basis for Design item is found to be incompatible with the design, contractor shall immediately bring that to the attention of the design team.

1.3 WARRANTY

- A. All materials and workmanship shall be warranted to be free from defects for a period of two (2) years following acceptance by the owner.
- B. If within two (2) year after the date of final acceptance of the installation, any of the work or equipment is found to be defective or not in compliance with the Contract Documents, the Contractor shall correct it promptly including all parts and labor.
- C. The Owner shall give notice to the Contractor of any defects promptly after the discovery of any defective condition.
- D. These obligations shall survive termination of the construction contract.

1.4 SUBMITTALS

- A. A detailed Bill of Materials (BOM) shall be provided in the format shown below:

Room No.	Manufacturer	Model	Description	Quantity	Price

- 1. Submit BOM with **bid**.
- B. Submit manufacturers’ data sheets for proposed systems, and equipment.
- C. Submit manufacturers’ data sheets for proposed systems, and equipment.
- D. Submit shop drawings for the AV system in each room showing system components and their connections to each other.
- E. Submit drawings showing proposed mounting details of all ceiling and/or wall mounted equipment. Attachment details as well as strength of all fastening and supporting materials shall be provided.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Goucher College expects full and completely operational systems to be provided. Items not included in the construction documents but required to provide this complete system shall be included. Where questions or discrepancies arise, these should be addressed **at bid time**.
- B. Where required for operation all software, licenses or other costs shall be included unless otherwise noted.

2.2 VIDEO DISPLAYS

- A. Displays shall be sized as indicated on the construction drawings.
- B. All displays shall meet the following minimum specifications:
 - 1. Pixel Resolution – 3840 x 2160
 - 2. Refresh Rate – 60 Hz
 - 3. Inputs :
 - a. HDMI (3)
 - b. DisplayPort
 - c. DVI-D (2)
 - d. PC (1)
 - 4. External Control – RS-232, IR
 - 5. Outputs:
 - a. Analog Audio
 - b. SPDIF
 - c. Left and Right channel speakers (min10w/channel)
 - 6. Acceptable Manufacturers
 - a. NEC
 - b. Panasonic
 - c. Other approved equal.

2.3 DIGITAL SWITCHING SYSTEM

- A. Provide an 8x4 scaling presentation matrix switcher that shall support up to eight inputs and four outputs for matrix switching of HDMI sources, one digital audio expansion port, 4K upscaling and downscaling, one integrated Extron IPCP Pro 350 control processor, plus additional support for signal extension over shielded CATx cable and audio digital signal processing with AEC.
- B. Basis of Design – Extron DTP CrossPoint 84 4K IPCP SA

2.4 DIGITAL TRANSMITTER

- A. Provide a two input Decora® wallplate twisted pair transmitter that shall support the distribution of video, audio, and control over a shielded CATx cable for the transmission of DisplayPort or HDMI, audio, and control.
- B. Basis of Design – Extron DTP T DWP 4K 232 D

2.5 DIGITAL RECIEVER

- A. Provide an HDMI twisted pair receiver that shall support the distribution of video, audio, and control over a shielded CATx cable.
- B. Basis of Design – Extron DTP HDMI 4K 230 Rx

2.6 CONTROL SYSTEM TOUCH PANEL

- A. Provide a wall mountable 5" capacitive touchscreen interface for switching and control of AV equipment.
- B. Basis of Design - Extron TLP Pro 520M

2.7 AUDIO AMPLIFIER

- A. Provide a compact, energy efficient audio amplifier that shall support two analog inputs and two amplified outputs with 60 watts rms power output per channel.
- B. Basis of Design - Extron XPA 1002

2.8 LOUDSPEAKERS

- A. Provide a two-way, 8 ohm surface mount speaker with a dual-ported enclosure, grille, crossover network, 8 ohm nominal impedance, and a concealed, lockable mounting system.
- B. Basis of Design – Extron SM 28.

2.9 USB CAMERA

- A. The USB camera shall meet the following specifications:
 - 1. Full HD 1080p video calling (up to 1920 x 1080 pixels); 720p HD video calling (up to 1280 x 720 pixels) with supported clients
 - 2. H.264/SVC video compression
 - 3. 90-degree field of view
 - 4. Zoom to 4X in 1080p
 - 5. ZEISS® lens certification
 - 6. Autofocus
 - 7. External privacy shutter
 - 8. Built-in dual stereo mics
 - 9. Hi-speed USB 2.0 certified (USB 3.0 ready)
- B. Basis of Design – Logitech C930E

2.10 WIRELESS MICROPHONE SYSTEM

- A. The wireless microphone system shall consist of wireless transmitters with microphones, wireless receivers, antenna(s), antenna, and cabling.
 - 1. Digital Wireless Bodypack Transmitter - Shall feature transparent 24-bit digital audio quality, and efficient RF spectrum usage, and offer the following:
 - a) Shall include Shure SM 35 headset microphone
 - b) AES 256-bit encryption for secure transmission
 - c) Over 120 dB of dynamic range – no transmitter gain adjustment needed
 - d) Frequency and power lockout
 - e) Basis of Design – Shure QLXD1/SM 35
 - 2. Digital Wireless Receiver - Featuring transparent 24 bit digital audio quality and RF spectrum usage. The receiver shall be a half-rack digital wireless receiver with automatic scanning to quickly finds open frequencies and quickly deploy them to transmitters. Ethernet networking shall enable networked channel scanning across multiple receivers. It shall provide:
 - a) 64 MHz tuning bandwidth
 - b) More than 60 preset compatible channels per frequency band
 - c) Up to 17 compatible systems per 6 MHz TV channel; 22 systems per 8 MHz channel
 - d) Digital predictive switching diversity
 - e) Automatic channel scan to quickly find the cleanest frequency
 - f) IR sync
 - g) Ethernet networking
 - h) Networked channel scan configures open frequencies for all connected receivers

- i) AES 256-bit encryption for secure wireless transmission
- j) Up to 60 dB of adjustable audio gain
- k) High-contrast LCD menu and controls with lockout feature
- l) Detachable ½ wave antennas
- m) Mic / line switchable XLR output
- n) ¼" instrument output
- o) Durable aluminum construction with brushed finish
- p) Professional-grade rack hardware
- q) Basis of Design – Shure QLXD4

2.11 2.10 ASSISTED LISTENING SYSTEM

A. Emitter

1. The Infrared Transmitter/Radiator Combo shall be capable of broadcasting up to two (2) audio channels with the choice of four (4) mono carrier frequencies; 2.3, 2.8, 3.3 and 3.8 MHz. Channel carrier selections shall be set via a back panel rotary switches. The Transmitter/Radiator coverage area shall be up to 7,500 ft² (697 m²) with single channel transmission. The device shall have a timer that shuts off the carriers after 15 minutes when no audio is present at the inputs. The Transmitter/Radiator shall have a SNR of 60 dB or better and THD of less than 2%. The device shall have an audio frequency response of 63 Hz to 15 kHz, +/- 3db. The device shall have two (2) independent mixing audio inputs, one for each transmission channel. Each mixing input shall consist of one (1) 3.5 mm Microphone input, one (1) balanced Phoenix type input and one (1) unbalanced RCA stereo summing input. The device shall have independent channel audio processing with Limiting, Compression and Noise Gate as well as transmit level control and level indication via an LEDs. The Transmitter/Radiator shall provide Power and RF signal for up to Four (4) Expansion Radiators over a single CAT-5e cable.
2. Basis of Design – Listen Technologies LT-84 Receiver

B. Receiver

1. The Lanyard IR Receiver shall be capable of receiving on four (4) carriers (2.3, 2.8, 3.3, 3.8 MHz) and the channel shall be displayed on one (1) of four (4) front panel LEDs. The receiver will accept mono or stereo earphones with a 3.5mm connector. The receiver shall be capable of being locked on a channel. The receiver shall be capable of receiving a stereo signal on each of the four carriers. The receiver shall have a SNR of 60 dB or greater and have built in squelch control. The device shall have an audio frequency response of 63 Hz to 15 kHz, +/- 3db and shall have distortion of less than 2%. The device shall operate for 30 hours with two AAA alkaline batteries and 15 hours with two AAA NiMH rechargeable batteries. The receiver shall be covered by a limited lifetime warranty.
2. A total of four (4) receivers shall be provided of which two (2) shall be equipped for use with t-coil equipped hearing aids.
3. Basis of Design - Listen Technologies LR-44

2.02 EQUIPMENT RACKS

A. Free-Standing Racks

1. Rack shall be of fully welded construction. Weight capacity shall be 750 lbs. when 1/2 of total equipment weight is mounted in lower 1/3 of the rack. Rack shall be constructed of the following materials: top and bottom (rack and outer frame) and roller carriage shall be 14-gauge steel; side panel and horizontal braces shall be 16-gauge

steel. Rackrail shall be constructed of 11-gauge steel with tapped 10-32 mounting holes in universal EIA spacing with black e-coat finish and marked rackspaces.

2. Rack shall have removable split rear knockout panels with 1/2", 3/4", 1" & 1-1/2" electrical knockouts installed in base and removable split rear knockout panels with 1/2", 3/4", 1" & 1-1/2" electrical knockouts installed in top.
3. Front doors shall be 16-gauge steel
4. Rear access panel shall be constructed of 18-gauge steel
5. Rack shall have sufficient space to house all components listed on the construction documents as being installed in the rack with an additional 20% spare rack space.
6. All unused rack spaces shall be provided with blank panels. If ventilation space is required perforated panels may be substitutes.
7. Basis for Design – Middle Atlantic WR 24-32

2.12 WIRE AND CABLE

A. General Requirements

1. Contractor shall provide all cables, patch cords or other wire required to provide a full and completely operational system. This includes any adapters required.
2. Wire and cable shall meet the following minimum specifications:
 - a) All wire and cable shall be UL listed.
 - b) All wire and cable shall meet individual subsystem manufacturer specifications.
 - c) All wire and cable shall conform to the minimum requirements of ICEA standards; and shall comply with applicable requirements of the National Electrical Code (NEC).
 - d) All wire and cable shall be plenum rated where routed beneath access flooring or in other areas where required.

B. HDMI Cables

1. HDMI cables shall be Category 2 certified cables capable of supporting 1080p60 HDTV with a minimum 16-bit color depth.
2. Cables shall have 24k gold plated contacts and a minimum 22AWG construction.

C. HDBaseT Cables

1. All cables for HDBaseT or similar proprietary formats shall be shielded Cat5e or better as recommended by the manufacturer.

D. Passive Faceplates

1. The faceplate shall be designed for a single-gang box and have the following features:
 - a) HDMI: HDMI female to HDMI female 10" pigtail
 - b) Computer video: 15-pin female to 15-pin female on 6" pigtail
 - c) Stereo audio: 3.5 mm stereo mini jack to captive screw
 - d) Signals passed through unprocessed
 - e) Supports DDC transmission — Facilitates EDID communication and HDCP exchange between the display and source.
 - f) HDCP compliant
 - g) Color shall be black.
 - h) Basis for Design – Extron WPB 109

E. Outlet Strips

1. The AV Contractor shall provide all requisite outlet strips in cabinets, lecterns, behind displays, etc. to provide power to any devices they provide as part of this contract.

PART 3 – EXECUTION

3.1 GENERAL

- A. Contractor shall install a full, complete, and operational system including all system components, cables and connectors. Omissions from the drawings and/or specifications do not relieve the contractor of this responsibility. Any such discrepancies found shall be promptly brought to the attention of the Owner or Owner's representative.
- B. Contractor shall install all components in accordance with manufacturers' instructions; Federal, State and local rules, and accepted industry practice.
- C. Contractor shall program and/or configure all system components.
- D. Contractor shall test all components and all connections, and shall insure that they operate in accordance with manufacturer's specifications.
- E. The locations of equipment, power outlets, boxes, etc. indicated on the drawings are approximate and are understood to be subject to such revision as may be found necessary or desirable at the time the work is executed. Coordinate exact location of all devices including mounting dimensions with architectural drawings. If not located on architectural drawings, coordinate with construction manager and all other related trades.
- F. Verify all locations and mounting dimensions in the field prior to installation.
- G. Locate equipment and accessories so as to provide easy access for proper service and maintenance.
- H. The locations of equipment, power outlets, boxes, etc. indicated on the drawings are approximately correct and are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed.
- I. Exercise particular caution with reference to the location of all field devices they have precise and definite locations accepted by the Owner/Architect before proceeding with the installation.
- J. The Contractor shall maintain a complete file of shop drawings and other submissions at the job site at all times. These shop drawings and submissions shall be made available to the Owner at his request.
- K. Keep all items protected before and after installation, with dust and moisture proof barrier materials. It shall be the contractor's responsibility to ensure the integrity of these protective measures throughout the life of the project.
- L. Contractor shall verify that the all amplifier/loudspeaker combinations produce the specified sound pressure level in each space.
- M. All cables and terminal strips shall be labeled with machine generated black uppercase lettering on a permanent adhesive label stock, covered with a permanent water resistant sealer. Labels shall be placed on both ends of the cable and no more than 6" from the point at which the cable is broken out into individual copper pairs or from the connector or terminal block. All labels shall be readily visible. Coordinate labeling requirements with Engineer/Owner.

- N. Hand lettered label stock shall not be accepted for final installation. Hand lettered stock is only acceptable for use with temporary labeling required during construction phases.
- O. If at any time during the project, the cable label becomes illegible or removed, the Contractor shall immediately replace it with a duplicate pre-printed cable label.
- P. All cable IDs shall be both physically and visually accessible upon completion of the project.

3.2 FIRE STOP PENETRATION SEALANT

- A. Provide fire-resistant materials of a type and composition necessary to restore fire ratings to all wall or floor or ceiling penetrations. Material must be properly classified and meet national and local codes.
- B. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of cold smoke, fire, toxic gas or water through the penetration either before, during or after a fire. The fire rating of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the National Electrical Code.
- C. No flammable material may be used to line the chase or hole in which the fire stop material is to be installed.
- D. When damming materials are to be left in place after the seal is complete, and then all such materials shall be non-flammable.
- E. The sealant shall remain resilient and pliable to allow the removal and/or addition of cable without the necessity of drilling holes. It shall adhere to itself perfectly to allow any and all repairs to be made with the same material. It shall allow for vibration, expansion and/or contraction of anything passing through the penetration without affecting the seal, or cracking, crumbling and spalling.
- F. When sealant is injected into a penetration, the material shall expand to surround all the items within the penetration and maintain pressure against the walls of the penetration as well as the pass-through items. The material shall cure within five minutes. No heat shall be required to further expand the material to prevent the passage of fire and smoke or water.
- G. The materials shall have been subjected to fire exposure in accordance with standard time-temperature curve in the Standard, UL, ASTM E 119 and NFPA 251. The fire stop material shall have also been subjected to the hose stream test in accordance with UL 10B.

3.3 ACOUSTIC PENETRATION SEALANT

- A. All penetrations through acoustically rated partitions shall be sealed airtight with a non-hardening acoustic sealant.

3.4 CONTROL SYSTEM

- A. Control system programming shall be accomplished in the following manner:
 - 1. Contractor personnel shall meet on-site with appropriate consultant and Owner's staff to develop a set of system requirements. Up to eight hours of on-site meeting time shall be provided.

2. Contractor shall document the requirements developed above and provide consultant and Owner's staff with that documentation for review.
 3. Upon approval of the requirements document, contractor shall develop detailed programming specifications to include:
 - a) A System Overview – Synopsis of project.
 - b) Equipment List – List of all equipment and functions to be controlled.
 - c) Drawings – Block and flow diagrams describing the program structure.
 - d) Interface layouts – Samples of the proposed display screen layouts.
 4. The detailed programming specifications shall be provided to the Owner's staff for final review.
 5. Upon receipt of final approval, Contractor shall program control system in accordance with the approved specifications.
 6. To the extent possible, all screens shall display a clock, volume control, and lighting level control.
- B. At minimum, control shall be provided for all features available on manufacturer supplied remote controls.
- C. Contractor shall provide an electronic version of the uncompiled source code for every room with a control system processor as part of the record documentation package.

3.5 TRAINING

- A. Contractor shall provide eight (8) hours of training and orientation of customer personnel to the new audio-visual systems.
- B. Training shall include, but will not be limited to:
1. Physical review of installed equipment.
 2. Review of documentation and test results.
 3. Additional customer requirement defined during the project.
- C. Contractor shall also provide any training of owner technicians required to maintain the manufacturer's warranty for the specified time period.
- D. Within the warranty period, the Contractor shall provide one site visit after system acceptance to provide remedial training and system adjustments that may be required. This visit shall be coordinated and scheduled with the owner.
- E. The Contractor shall be on call during the warranty period to answer any questions of the Owner.

3.6 ACCEPTANCE TESTING

- A. Submit a detailed acceptance test procedure designed to demonstrate compliance with contract requirements at least 4 weeks before the start of testing. This procedure to be approved prior to the start of the testing.
- B. During acceptance testing provide services of a fully qualified security communication systems technician who is knowledgeable of the project.

- C. Using the commissioning test data the Owner and/or his representative shall select, at random, functions to be demonstrated. The Contractor in accordance with the acceptance test procedure shall demonstrate these functions.
- D. Furnish instruments required for testing. Submit catalog data on all instruments for approval prior to performance of tests.
- E. After the acceptance tests are complete and the system is demonstrated to be functioning as specified, a thirty-day endurance test period shall begin. If the system functions as specified throughout the endurance test period requiring only routine maintenance and adjustment, the system shall be accepted. If during the endurance test period the system fails to perform as specified and cannot be corrected within eight hours, the Owner may request that the endurance tests be repeated after problems have been corrected.

3.7 VERIFICATION TESTING

- A. At the time of substantial completion, but before final acceptance, contractor shall participate in verification testing to be performed by the Owner and its representative.
- B. Verification testing shall include a review of the results of the Contractor Testing, as well as any additional operational or functional testing desired by the Owner.
- C. Any item or function that fails to meet the requirements of these documents shall be promptly repaired or replaced and re-tested prior to final acceptance by the Owner.

3.8 RECORD DOCUMENTATION

- A. Prior to final acceptance of the work, the Contractor shall submit one (1) set of record documentation.
- B. Record documentation shall include:
 - 1. Floor plan drawings indicating device locations and wire routing.
 - 2. Functional block diagrams.
 - 3. Drawings shall be provided in both hard copy and in electronic format.
 - 4. Electronic copies of all uncompiled control system program code.
- C. Record documentation shall also include operation and maintenance manuals for all components of the system. Manuals shall include:
 - 1. Installation and Service manuals.
 - 2. Operating manuals.
 - 3. If not included in the above manuals, the Contractor shall provide:
 - a) Power up and power down procedures.
 - b) Programming procedures.
 - c) Maintenance schedules.
 - d) Diagnostic procedures.

END OF SECTION 27 41 00

SECTION 28 1300

ELECTRONIC ACCESS 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.

1.2 WORK INCLUDED

- A. The Contractor shall provide all hardware, software, materials, plans, supplies, labor, training, maintenance, design, engineering, management, and supervision necessary to make the specified systems and services fully operational.
- B. All equipment provided by the Contractor shall be new, of current design, and shall provide the specific capabilities, software features, and functions which shall have been tested, accepted, utilized, and have the endorsement of at least five (5) other users for a period of at least twelve (12) months.
- C. Contractor shall provide all readers, reader interfaces, access control panels, and all other hardware and software necessary to provide a full, complete and functioning system.
- D. DSX Access Control system - The access control system currently in use at Goucher is the DSX system. All components shall be part of that system or identified by the manufacturer as compatible.

1.3 QUALITY ASSURANCE

- A. All equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Specification shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based on the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified, and subject to approval.

1.4 SUBMITTALS

- A. Submit manufacturers' data sheets for all proposed equipment.
- B. Submit a detailed bill-of-materials listing all part numbers and quantities that the Bidder proposes to use in this project.

PART 2 – PRODUCTS

2.1 PRODUCTS GENERAL

- A. Contractor shall furnish any license upgrades required to accommodate the equipment furnished under this contract.

2.2 FIELD HARDWARE

- A. The Access Control System shall be equipped with the access control field hardware required to administer all access granted/denied decisions. All field hardware must be designed to meet UL requirements. Depending upon the configuration, the Access Control System field hardware may include any or all of the following components:
 - 1. Intelligent System Controller – DSX Intelligent 1040 series (actual model to be based on final number of openings).
 - 2. Network Interface Device - DSXLAN
 - 3. Card Readers – Proximity reader compatible with DSX system.
 - 4. Door Position Sensors – Furnished as part of door hardware contract.
 - 5. Power Supplies for field hardware shall be designed specifically for the system equipment installed. All power supplies shall be housed in locked enclosures that also allow mounting space for any device/panel required. All power supplies shall be connected to emergency power circuits provided in telecom rooms.

2.3 WIRE AND CABLE

- A. Contractor shall furnish and install all cabling required to provide a complete and functioning system.
- B. All cables shall be as required by the manufacturer and suitable for the distances encountered.
- C. All cables shall be suitable and listed for the environment in which they are installed.

PART 3 – EXECUTION

3.1 EXECUTION GENERAL

- A. All installations shall be in accordance with manufacturers' installation documents and be compliant with all local, state, and national codes.
- B. Contractor shall furnish and install all components, cables, and other items required to provide a full and functioning system with the capabilities intended as evidenced in the construction documents.

- C. Where discrepancies in the construction documents or uncertainties in terms of the intent of the documents exist, contractor shall execute a written request for information and forward it to the design team. Contractor shall not be relieved of its obligation under these documents due to its failure to request clarification or additional information in a timely manner.

- D. Current site conditions: the contractor shall visit the site and verify that site conditions are in agreement with the design package. The contractor shall report all changes to the site or conditions that will affect performance of the system to the owner. The contractor shall not take any corrective action without written permission from the owner.

- E. Panels
 - 1. The Control Panel, the Door Reader Modules, expansion boards, and power supplies are to be installed in the Main Telecommunications room, in appropriately sized lockable metal enclosures. The enclosures shall be labeled with the type of component, and the devices served by that component.
 - 2. Contractor to make all required network connections. Any required IP address shall be provided to the contractor by the University for programming of the Network connection.
 - 3. All cable connections to be standard direct cable connections.
 - 4. Field Devices
 - a) Card Readers to be mounted (appropriately attached to wall) as shown on the construction drawings.

3.2 SYSTEM PROGRAMMING

- A. Contractor shall meet with appropriate college personnel to establish the base system programming required for each of the systems.

- B. Contractor shall document these requirements for review, comment, and approval by the owner and the design team.

- C. Upon approval of the configuration requirements, contractor shall configure the systems as documented.

- D. In programming the system, contractor shall implement the following sequence of operations.

DOOR TYPE	SEQUENCE OF OPERATIONS
Door equipped with card reader	Door is locked based on an owner determined schedule that has been programmed into the access control system. When door is "unlocked" free passage is allowed without use of a proximity card. Passage through the "unlocked" door does not create an alarm event on the access control monitoring system. When the door is "locked" and in "card-only" mode, a

	<p>valid card read shunts the alarm for the owner determined shunt time and unlocks the door allowing free passage. Failure of the door to close completely before the expiration of the shunt time will create a “door held” alarm event on the access control monitoring system. When the door is “locked” and in “card-only” mode, activation of the Request-to-Exit switch in the hardware set shunts the alarm for the owner determined shunt time and allows egress through the door without creating an alarm event on the access control monitoring system. Failure of the door to close completely before the expiration of the shunt time will create a “door held” alarm event on the access control monitoring system. When in “locked” mode, opening of the door without either a valid card read, or activation of the interior Request-To-Exit switch will create a “door forced” alarm on the access control monitoring system.</p>
Door monitored with Door Position Switch only	<p>Door is monitored based on an owner determined schedule that has been programmed into the access control system. When door is “unlocked” free passage is allowed. Passage through the “unlocked” door does not create an alarm event on the access control monitoring system. When the door is in “locked” mode, activation of the Request-to-Exit switch in the hardware set shunts the alarm for the owner determined shunt time and allows egress through the door without creating an alarm event on the access control monitoring system. Failure of the door to close completely before the expiration of the shunt time will create a “door held” alarm event on the access control monitoring system. When in “locked” mode, opening of the door without activation of the interior motion sensor will create a “door forced” alarm on the access control monitoring system.</p>
Door with Card Reader and Electric Operator	<p>Door is locked and monitored based on an owner determined schedule that has been programmed into the access control system. When door is “unlocked” free passage is allowed and the operator control functions normally. Passage through the “unlocked” door does not create an alarm event on the access control monitoring system. When the door is in “locked” and “card only” mode, the operating paddle does not open the door unless preceded by a valid card read. When locked and in “card only” mode, operation of the interior paddle acts as a Request-to-exit switch and shunts the alarm for the owner determined shunt time and allows egress through the door without creating an alarm event on the access control monitoring system. Failure of the door to close completely before the expiration of the shunt time will create a “door held” alarm event on the access control monitoring system. When in “locked” mode, opening of the door without a valid card read or activation of the Request-to-Exit device will create a “door forced” alarm on the access control monitoring system.</p>

3.3 RECORD DOCUMENTATION

- A. Prior to final acceptance of the work, the Contractor shall submit two (2) sets of record documentation.
- B. Record documentation shall include:
 - 1. Floor plan drawings indicating device locations and wire routing.
 - 2. Functional block diagrams.
 - 3. Drawings shall be provided in both hard copy and in electronic format. The electronic format shall be the most recent version of AutoCAD.
 - 4. Installation and Service manuals.

5. Operating manuals.

3.4 TESTING

- A. Prior to final acceptance of the work, the Contractor shall perform and document the following minimum testing:
 1. Verify that all equipment provided is functioning to manufacturers' specifications.
 2. Verify that all access control and alarm signals are transmitting properly.
 3. Verify that all access controlled doors are properly responding to the following test conditions:
 - a) Valid card read
 - b) Invalid card read
 - c) Door forced open
 - d) Door ajar/Door held open
- B. Contractor shall document its testing in a report that includes the following minimum information:
 1. Date of Test
 2. Location of Test
 3. Name of Person Performing Test
 4. Type of Test
 5. Outcome of Initial Test
 6. Remedial Action Taken in Event of Failure
 7. Date of Re-Test
 8. Outcome of Re-Test

3.5 VERIFICATION TESTING

- A. At the time of substantial completion, but before final acceptance, contractor shall participate in verification testing to be performed by the Owner and its representative.
- B. Verification testing shall include a review of the results of the Contractor Testing, as well as any additional operational or functional testing desired by the Owner.
- C. Any item or function that fails to meet the requirements of these documents shall be promptly repaired or replaced and re-tested prior to final acceptance by the Owner.

END OF SECTION 28 1300

SECTION 28 4621.11

ADDRESSABLE FIRE-ALARM SYSTEM

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. Fire-alarm control unit.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Notification appliances.
 - 5. Magnetic door holders.
 - 6. Remote annunciator.
 - 7. Addressable interface device.
 - 8. Network communications.

1.3 DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. FACP: Fire Alarm Control Panel.
- C. NICET: National Institute for Certification in Engineering Technologies.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
 - 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, and electrical characteristics.
- B. Shop Drawings: For fire-alarm system.
 - 1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - 2. Include plans, elevations, sections, details, and attachments to other work.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 - 4. Detail assembly and support requirements.
 - 5. Include voltage drop calculations for notification-appliance circuits.

6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level III minimum.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.

1.6 SAMPLE WARRANTY: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components 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. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" per the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
 - d. Riser diagram.
 - e. Device addresses.
 - f. Record copy of site-specific software.
 - g. Provide "Inspection and Testing Form" per the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.

- h. Manufacturer's required maintenance related to system warranty requirements.
- i. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

- 1. Software operating and upgrade manuals.
- 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
- 3. Device address list.
- 4. Printout of software application and graphic screens.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.9 PROJECT CONDITIONS

- A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.
- B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
 - 2. Do not proceed with interruption of fire-alarm service without Owner's written permission.
- C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.10 SEQUENCING AND SCHEDULING

- A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
- B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.
- C. Automatic sensitivity control of smoke detectors.
- D. All components provided shall be listed for use with the selected system.
- E. 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.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices:
 - 1. Manual stations.
 - 2. Smoke detectors.
 - 3. Automatic sprinkler system water flow.
 - 4. Fire standpipe system.
- B. Fire-alarm signal shall initiate the following actions:
 - 1. Continuously operate alarm notification appliances.
 - 2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
 - 3. Release fire and smoke doors held open by magnetic door holders.
 - 4. Recall elevators to primary or alternate recall floors.
 - 5. Activate elevator power shunt trip.
 - 6. Activate emergency lighting control.
 - 7. Record events in the system memory.
 - 8. Indicate device in alarm on the remote annunciator.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
 - 1. Valve supervisory switch.
 - 2. Elevator shunt-trip supervision.
 - 3. User disabling of zones or individual devices.
 - 4. Loss of communication with any panel on the network.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
 - 1. Open circuits, shorts, and grounds in designated circuits.
 - 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.

3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Hose cabinet door open.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
4. Transmit system status to building management system.
5. Display system status on remote annunciator.

2.3 FIRE-ALARM CONTROL UNIT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Gamewell - FCI by Honeywell.
2. GE UTC Fire & Security; A United Technologies Company.
3. Edwards Signaling.
4. Notifier.
5. Siemens Industry, Inc.; Fire Safety Division.
6. Silent Knight.
7. Simplex Grinnell LP.

B. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 - a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder.
 - c. Provide communication between the FACP and remote annunciator.
 - d. The FACP shall be listed for connection to a central-station signaling system service.
 - e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.

3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
- C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
- D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
 1. Pathway Class Designations: NFPA 72, Class B.
 2. Pathway Survivability: Level 0.
 3. Serial Interfaces:
 - a. One dedicated RS 485 port for central-station operation using point ID DACT.
 - b. One RS 485 port for remote annunciators.
- E. Notification-Appliance Circuit:
 1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
 2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
- F. Elevator Recall:
 1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
 - a. Elevator lobby detectors except the lobby detector on the designated floor.
 - b. Smoke detectors in elevator hoistway.
 2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
 3. Water-flow alarm connected to sprinkler in an elevator shaft shall shut down elevators associated with the location without time delay.
- G. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.
- H. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals shall be powered by 24-V dc source.
 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- I. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 1. Batteries: Sealed lead calcium.

- J. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Gamewell - FCI by Honeywell.
 2. GE UTC Fire & Security; A United Technologies Company.
 3. Notifier.
 4. Siemens Industry, Inc.; Fire Safety Division.
 5. Silent Knight.
 6. SimplexGrinnell LP.
- B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 2. Station Reset: Key- or wrench-operated switch.
 3. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

2.5 SYSTEM SMOKE DETECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Gamewell - FCI by Honeywell.
 2. GE UTC Fire & Security; A United Technologies Company.
 3. Notifier.
 4. Siemens Industry, Inc.; Fire Safety Division.
 5. Silent Knight.
 6. SimplexGrinnell LP.
- B. General Requirements for System Smoke Detectors:
1. Comply with UL 268; operating at 24-V dc, nominal.
 2. Detectors shall be two-wire type.
 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.

2.6 NOTIFICATION APPLIANCES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Wheelock.
 2. Federal Signal Corporation.
 3. GE UTC Fire & Security; A United Technologies Company.
 4. Siemens Industry, Inc.; Fire Safety Division.
- B. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.
 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.
- D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
 1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 2. Mounting: Wall mounted unless otherwise indicated.
 3. Flashing shall be in a temporal pattern, synchronized with other units.
 4. Strobe Leads: Factory connected to screw terminals.
 5. Mounting Faceplate: Factory finished, red.

2.7 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
 1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 3. Rating: 24-V ac or dc.
 4. Rating: 120-V ac.

- B. Material and Finish: Match door hardware.

2.8 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: Flush cabinet, NEMA 250, Type 1.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.9 ADDRESSABLE INTERFACE DEVICE

- A. General:
 - 1. Include address-setting means on the module.
 - 2. Store an internal identifying code for control panel use to identify the module type.
 - 3. Listed for controlling HVAC fan motor controllers.
- B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall.
 - 1. Allow the control panel to switch the relay contacts on command.
 - 2. Have a minimum of two normally open and two normally closed contacts available for field wiring.
- D. Control Module:
 - 1. Operate notification devices.
 - 2. Operate solenoids for use in sprinkler service.

2.10 NETWORK COMMUNICATIONS

- A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.
- B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.
- C. Provide integration gateway using BACnet for connection to building automation system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
 - 1. Connect new equipment to existing control panel in existing part of the building.
 - 2. Connect new equipment to existing monitoring equipment at the supervising station.
 - 3. Expand, modify, and supplement existing [control] [monitoring] equipment as necessary to extend existing [control] [monitoring] functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
- C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.
- D. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
 - 2. Mount manual fire-alarm box on a background of a contrasting color.
 - 3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

- F. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
- G. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- H. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- I. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- J. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.
- K. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

- A. Pathways shall be installed in EMT.
- B. Exposed EMT shall be painted red enamel.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Perform the following tests and inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 3. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- 3.7 DEMONSTRATION
- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 3111

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] [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.
- D. 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 (50 mm) in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

- E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.
- F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and [indicated on Drawings] [indicated according to requirements in Section 015639 "Temporary Tree and Plant Protection."] <Insert requirement>.
- G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

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.
- E. Burning: Documentation of compliance with burning requirements and permitting of authorities having jurisdiction. Identify location(s) and conditions under which burning will be performed.

1.7 QUALITY ASSURANCE

- A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

- B. Rock Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.8 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. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 - 1. Do not proceed with work on adjoining property until directed by Architect.
- C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises[where indicated] <Insert location>.
- D. Utility Locator Service: Notify [utility locator service] [Miss Utility] [Call Before You Dig] [Dig Safe System] [One Call] <Insert name> for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion- and sedimentation-control[and plant-protection] measures are in place.
- F. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- G. 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.
- B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with [MPI #23 (surface-tolerant, anticorrosive metal primer)] [or] [SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating] <Insert requirement>.

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.
 - 2. Owner will arrange to shut off indicated utilities when requested by Contractor.
- 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] <Insert number> 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.
- F. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition."

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 (50 mm)] [3 inches (75 mm)] <Insert dimension> in diameter, obstructions, and debris to a depth of [18 inches (450 mm)] <Insert dimension> below exposed subgrade.
 - 3. Use only hand methods or air spade for grubbing within protection zones.
 - 4. Chip removed tree branches and [stockpile in areas approved by Architect] [dispose of off-site] <Insert requirement>.
- 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 (200 mm), 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 [indicated on Drawings] [of 6 inches (150 mm)] <Insert requirement> 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 (50 mm) 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 (1800 mm)] <Insert dimension>.
 2. Do not stockpile topsoil within protection zones.
 3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
 4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 STOCKPILING ROCK

- A. Remove from [area indicated on Drawings] [construction area] <Insert requirement> naturally formed rocks that measure more than [1 foot (300 mm)] <Insert dimension> 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 (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.
- B. Stockpile rock [where indicated on Drawings] [away from edge of excavations] <Insert requirement> without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.
1. Limit height of rock stockpiles to [36 inches (900 mm)] <Insert dimension>.
 2. Do not stockpile rock within protection zones.
 3. Dispose of surplus rock. Surplus rock is that which exceeds quantity indicated to be stockpiled or reused.
 4. Stockpile surplus rock to allow later use by the Owner.

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.
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.
- B. Burning tree, shrub, and other vegetation waste is permitted according to burning requirements and permitting of authorities having jurisdiction. Control such burning to produce the least smoke or air pollutants and minimum annoyance to surrounding properties. Burning of other waste and debris is prohibited.
- C. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

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. 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 pavement.
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.
9. Excavating well hole to accommodate elevator-cylinder assembly.

B. Related Requirements:

1. Section 013233 "Photographic Documentation" for recording preexcavation and earth-moving progress.
2. Section 033000 "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
3. Section 311000 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
4. Section 312319 "Dewatering" for lowering and disposing of ground water during construction.
5. Section 315000 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
6. Section 316329 "Drilled Concrete Piers and Shafts" for excavation of shafts and disposal of surplus excavated material.
7. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
8. Section 329300 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices for earth moving specified in Section 012200 "Unit Prices."

- B. Quantity allowances for earth moving are included in Section 012100 "Allowances."
- C. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials.
 - 1. 24 inches (600 mm) outside of concrete forms other than at footings.
 - 2. 12 inches (300 mm) outside of concrete forms at footings.
 - 3. 6 inches (150 mm) outside of minimum required dimensions of concrete cast against grade.
 - 4. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 - 5. 6 inches (150 mm) beneath bottom of concrete slabs-on-grade.
 - 6. 6 inches (150 mm) beneath pipe in trenches, and the greater of [24 inches (600 mm) wider than pipe or 42 inches (1065 mm) wide.

1.4 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 (3 m) in width and more than 30 feet (9 m) 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, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.

- H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. (0.76 cu. m) for bulk excavation or 3/4 cu. yd. (0.57 cu. m) for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
 - 1. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- (1065-mm-) maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp (103-kW) flywheel power with bucket-curling force of not less than 28,700 lbf (128 kN) and stick-crowd force of not less than 18,400 lbf (82 kN) with extra-long reach boom.
 - 2. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp (172-kW) flywheel power and developing a minimum of 47,992-lbf (213.3-kN) breakout force with a general-purpose bare bucket.
- I. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. (0.57 cu. m) or more in volume that exceed a standard penetration resistance of 100 blows/2 inches (97 blows/50 mm) when tested by a geotechnical testing agency, according to ASTM D 1586.
- J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- K. 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.
- L. 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.
- M. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct preexcavation conference at Interfaith Center.
 - 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.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
 - 1. Geotextiles.
 - 2. Controlled low-strength material, including design mixture.
 - 3. Geofoam.
 - 4. Warning tapes.
- B. Samples for Verification: For the following products, in sizes indicated below:
 - 1. Geotextile: 12 by 12 inches (300 by 300 mm).
 - 2. Warning Tape: 12 inches (300 mm) long; of each color.

1.7 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 D 2487.
 - 2. Laboratory compaction curve according to ASTM D 1557.
- C. Blasting plan approved by authorities having jurisdiction.
- D. Seismic survey report from seismic survey agency.
- E. Preexcavation 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.

1.8 QUALITY ASSURANCE

- A. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:
 - 1. Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
 - 2. Seismographic monitoring during blasting operations.
- B. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:
 - 1. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
 - 2. Seismographic monitoring during blasting operations.

- C. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.9 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. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 - 1. Do not proceed with work on adjoining property until directed by Architect.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.
- D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in [Section 015000 "Temporary Facilities and Controls" are in place.
- E. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.
- F. 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.
- G. Do not direct vehicle or equipment exhaust towards protection zones.
- H. 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 D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
 - 1. Liquid Limit: <Insert value>.
 - 2. Plasticity Index: <Insert value>.
- C. Unsatisfactory Soils: Soil Classification [Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, 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 D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 294/D 2940M 0; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
- H. Drainage Course: Narrowly graded mixture of [washed]crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and zero to 5 percent passing a No. 8 (2.36-mm) sieve.
- I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and zero to 5 percent passing a No. 4 (4.75-mm) sieve.
- J. Sand: ASTM C 33/C 33M; 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: Class 2; AASHTO M 288.
 - 2. Survivability: As follows:

- a. Grab Tensile Strength: 157 lbf (700 N); ASTM D 4632.
 - b. Sewn Seam Strength: 142 lbf (630 N); ASTM D 4632.
 - c. Tear Strength: 56 lbf (250 N); ASTM D 4533.
 - d. Puncture Strength: 56 lbf (250 N); ASTM D 4833.
3. Apparent Opening Size: [No. 40 (0.425-mm)] [No. 60 (0.250-mm)] [No. 70 (0.212-mm)] sieve, maximum; ASTM D 4751.
 4. Permittivity: 0.2 per second, minimum; ASTM D 4491.
 5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
- 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: Class 2; AASHTO M 288.
 2. Survivability: As follows:
 - a. Grab Tensile Strength: 247 lbf (1100 N); ASTM D 4632.
 - b. Sewn Seam Strength: 222 lbf (990 N); ASTM D 4632.
 - c. Tear Strength: 90 lbf (400 N); ASTM D 4533.
 - d. Puncture Strength: 90 lbf (400 N); ASTM D 4833.
 3. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.
 4. Permittivity: 0.02 per second, minimum; ASTM D 4491.
 5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

- A. Controlled Low-Strength Material: Self-compacting, low-density, flowable concrete material produced from the following:
1. Portland Cement: ASTM C 150/C 150M, Type II.
 2. Fly Ash: ASTM C 618, Class C or F.
 3. Normal-Weight Aggregate: ASTM C 33/C 33M, 3/4-inch (19-mm) nominal maximum aggregate size.
 4. Foaming Agent: ASTM C 869/C 869M.
 5. Water: ASTM C 94/C 94M.
 6. Air-Entraining Admixture: ASTM C 260/C 260M.
- B. Produce low-density, controlled low-strength material with the following physical properties:
1. As-Cast Unit Weight: 36 to 42 lb/cu. ft. (576 to 675 kg/cu. M) at point of placement, when tested according to ASTM C 138/C 138M.
 2. Compressive Strength: 140 psi (965 kPa), when tested according to ASTM C 495/C 495M.
- C. Produce conventional-weight, controlled low-strength material with 140-psi (965-kPa) compressive strength when tested according to ASTM C 495/C 495M.

2.4 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) 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 (150 mm) wide and 4 mils (0.1 mm) 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 (750 mm) 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. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. 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.

3.3 EXPLOSIVES

- A. Explosives: Do not use explosives.
- B. Explosives: Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.
 - 1. Perform blasting without damaging adjacent structures, property, or site improvements.
 - 2. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

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 (600 mm) outside of concrete forms other than at footings.
 - b. 12 inches (300 mm) outside of concrete forms at footings.
 - c. 6 inches (150 mm) 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 (150 mm) beneath bottom of concrete slabs-on-grade.
 - f. 6 inches (150 mm) beneath pipe in trenches and the greater of 24 inches (600 mm) > wider than pipe or 42 inches (1065 mm) wide.
- B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.
 - 1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.
 - a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
 - 2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

- a. 24 inches (600 mm) outside of concrete forms other than at footings.
- b. 12 inches (300 mm) outside of concrete forms at footings.
- c. 6 inches (150 mm) 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 (150 mm) beneath bottom of concrete slabs-on-grade.
- f. 6 inches (150 mm) beneath pipe in trenches and the greater of 24 inches (600 mm) > wider than pipe or 42 inches (1065 mm) wide.

3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). 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 (150 to 300 mm) 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 (25 mm). 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 (300 mm) higher than top of pipe or conduit unless otherwise indicated.
 - 1. Clearance: 12 inches (300 mm) each side of pipe or conduit
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 - 1. For pipes and conduit less than 6 inches (150 mm) in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 - 2. For pipes and conduit 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
 - 3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
 - 4. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- D. Trench Bottoms: Excavate trenches 4 inches (100 mm) deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
 - 1. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- E. 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 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 (5 km/h).
 - 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 (17.2 MPa), 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 (450 mm)] <Insert dimension> 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."] [Section 033053 "Miscellaneous Cast-in-Place Concrete."]
- D. Trenches under Roadways: Provide [4-inch- (100-mm-)] <Insert dimension> thick, concrete-base slab support for piping or conduit less than [30 inches (750 mm)] <Insert dimension> below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of [4 inches (100 mm)] <Insert dimension> of concrete before backfilling or placing roadway subbase course. Concrete is specified in [Section 033000 "Cast-in-Place Concrete."] [Section 033053 "Miscellaneous 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 [subbase material] [satisfactory soil], free of particles larger than [1 inch (25 mm)] <Insert dimension> in any dimension, to a height of 12 inches (300 mm) 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.
 - 2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches (300 mm) over the pipe 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.
 - 2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.
- H. Warning Tape: Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) 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 (200 mm) in loose depth for material compacted by heavy compaction equipment and not more than 4 inches (100 mm) 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 D 1557:
 - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.
 - 2. Under walkways, scarify and recompact top 6 inches (150 mm) 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 (150 mm) 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 (25 mm).
 2. Walks: Plus or minus 1 inch (25 mm).
 3. Pavements: Plus or minus 1/2 inch (13 mm).
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

3.18 SUBSURFACE DRAINAGE

- A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch (150-mm) course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches (300 mm) of filter material, placed in compacted layers 6 inches (150 mm) thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).
1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.
 2. Retain "Drainage Backfill" Paragraph below if using free-draining granular backfill against walls.
- B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches (300 mm) of final subgrade, in compacted layers 6 inches (150 mm) thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).
1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.
 2. Place and compact impervious fill over drainage backfill in 6-inch- (150-mm-) thick compacted layers to final subgrade.

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 (150 mm) or less in compacted thickness in a single layer.
5. Place subbase course and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) 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 D 1557.

- C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

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 (150 mm) or less in compacted thickness in a single layer.
 3. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) 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 D 698.

3.21 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
 2. Determine that fill material classification and maximum lift thickness comply with requirements.
 3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.
- B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

- C. 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.
- D. 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.
- E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, 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. (186 sq. m) 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 (30 m) 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 (46 m) or less of trench length but no fewer than two tests.
- F. 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. Cold milling of existing asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt overlay.
5. Asphalt curbs.
6. Asphalt traffic-calming devices.
7. Asphalt surface treatments.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for demolition and removal of existing asphalt pavement.
2. Section 312000 "Earth Moving" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
3. Section 321313 "Concrete Paving" for concrete pavement and for separate concrete curbs, gutters, and driveway aprons.
4. Section 321373 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.
5. Section 321400 "Unit Paving" for bituminous setting bed for pavers and for stone and precast concrete curbs.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at the Interfaith Center.

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: For each type of product.
 - 1. Include technical data and tested physical and performance properties.
 - 2. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
 - 3. Job-Mix Designs: For each job mix proposed for the Work.
- B. Sustainable Design Submittals:
- C. Samples for Verification: For the following product, in manufacturer's standard sizes unless otherwise indicated:
 - 1. Paving Fabric: 12 by 12 inches (300 by 300 mm) minimum.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and testing agency.
- B. Material Certificates: For each paving material. Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.
- C. Material Test Reports: For each paving material, by a qualified testing agency.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.
- B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
- C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of State Highway Administration of Maryland 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. Prime Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
 - 2. Tack Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
 - 3. Slurry Coat: Comply with weather limitations in ASTM D 3910.

4. Asphalt Base Course: Minimum surface temperature of 40 deg F (4.4 deg C) and rising at time of placement.
5. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.6 deg C) 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 D 692/D 692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
- C. Fine Aggregate: AASHTO M 29, 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.
- D. Mineral Filler: AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

- A. Asphalt Binder: ASTM D 6373 or AASHTO M 320 binder designation PG 64-22.
- B. Asphalt Cement: ASTM D 3381/D 3381M for viscosity-graded material
- C. Retain "Cutback Prime Coat" or "Emulsified Asphalt Prime Coat" Paragraph below if surface-applied prime coats are required. Benefits of a prime coat include temporary protection of the granular base from moisture, binding surface fine aggregate, and promoting bond of the paving course to the granular course. These benefits have been disputed in the asphalt industry. In first paragraph, "MC-30" and "MC-70" are used on close-textured surfaces; "MC-250" is used on open-textured bases. Where use of cutback asphalt is restricted by air pollution regulations or water quality-control restrictions, retain second paragraph.
- D. Cutback Prime Coat: ASTM D 2027/D 2027M, medium-curing cutback asphalt, MC-30 or MC-70.
- E. Emulsified Asphalt Prime Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397/D 2397M or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
- F. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397/D 2397M or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

- G. Fog Seal: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397/D 2397M [or] [AASHTO M 208] cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.
- H. Water: Potable.
- I. Undersealing Asphalt: ASTM D 3141/D 3141M; pumping consistency.

2.3 AUXILIARY MATERIALS

- A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled [tires] [asphalt shingles] [or] [glass] from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.
- B. 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.
- C. Sand: ASTM D 1073 or AASHTO M 29, Grade No. 2 or No. 3.
- D. Paving Geotextile: AASHTO M 288 paving fabric; nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.
- E. Joint Sealant: ASTM D 6690, Type II or III, hot-applied, single-component, polymer-modified bituminous sealant.

2.4 MIXES

- A. <Double click to insert sustainable design text for recycled content.>
 - 1. Surface Course Limit: Recycled content no more than 10 percent by weight.
- B. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes designed according to procedures in AIMS-2, "Asphalt Mix Design Methods"; 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: 19mm
 - 3. Surface Course: 12.5mm
- C. Emulsified-Asphalt Slurry: ASTM D 3910, Type 1 .

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 (5 km/h).
 - 2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
 - 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 (50 mm)
 - 2. 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 (25 mm) after milling, before wearing course is laid.
 - 7. Handle milled asphalt material according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."
 - 8. Keep milled pavement surface free of loose material and dust.
 - 9. 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 (300 mm) 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. (0.2 to 0.7 L/sq. m).
 - 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 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.
- E. Placing Patch Material: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

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 (25 mm) in existing pavements.
 - 1. Install leveling wedges in compacted lifts not exceeding 3 inches (75 mm) thick.
- B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of [1/4 inch (6 mm)] <Insert dimension>.
 - 1. Clean cracks and joints in existing hot-mix asphalt pavement.
 - 2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.
 - 3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.

3.6 SURFACE PREPARATION

- A. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

- B. Herbicide Treatment: Apply herbicide according to 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. Cutback Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. (0.7 to 2.3 L/sq. m). Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.
 - 1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
 - 2. Protect primed substrate from damage until ready to receive paving.
- D. Emulsified Asphalt Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.10 to 0.30 gal./sq. yd. per inch depth (0.5 to 1.40 L/sq. m per 25 mm depth). Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.
 - 1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
 - 2. Protect primed substrate from damage until ready to receive paving.
- E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
 - 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 PAVING GEOTEXTILE INSTALLATION

- A. Apply tack coat uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd. (0.8 to 1.2 L/sq. m).
- B. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches (100 mm) and transverse joints 6 inches (150 mm).
- C. Protect paving geotextile from traffic and other damage, and place hot-mix asphalt overlay the same day.

3.8 PLACING HOT-MIX ASPHALT

- 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 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 (121 deg C).
 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 (3 m) 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 (25 to 38 mm) from strip to strip to ensure proper compaction of mix along longitudinal joints.
 2. Complete a section of asphalt base 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.

3.9 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 (150 mm).
 3. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
 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 according to 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.

3.10 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 (85 deg C).
- 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: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent or greater than 100 percent.
 - 2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041/D 2041M, 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.

3.11 ASPHALT CURBS

- A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at a minimum temperature of 250 deg F (121 deg C).
 - 1. Asphalt Mix: Same as pavement surface-course mix.
- B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.12 ASPHALT TRAFFIC-CALMING DEVICES

- A. Construct hot-mix asphalt speed humps over compacted pavement surfaces. Apply a tack coat unless pavement surface is still tacky and free from dust. Spread mix at a minimum temperature of 250 deg F (121 deg C).
 - 1. Tack Coat Application: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m.).
 - 2. Asphalt Mix: Same as pavement surface-course mix.
 - 3. Before installation, mill pavement that will be in contact with bottom of traffic-calming device. Mill to a depth of 1 inch (25 mm) from top of pavement to a clean, rough profile.

- B. Place and compact hot-mix asphalt to cross section indicated, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.13 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/2 inch (13 mm).
 - 2. Surface Course: Plus 1/4 inch (6 mm), no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch (6 mm)
 - 2. Surface Course: 1/8 inch (3 mm)
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).
- C. Asphalt Traffic-Calming Devices: Compact and form asphalt to produce the contour indicated and within a tolerance of plus or minus 1/8 inch (3 mm) of height indicated above pavement surface.

3.14 SURFACE TREATMENTS

- A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. (0.45 to 0.7 L/sq. m) to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.
- B. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.
 - 1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

3.15 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 according to ASTM D 3549/D 3549M.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- D. Asphalt Traffic-Calming Devices: Finished height of traffic-calming devices above pavement will be measured for compliance with tolerances.

- E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979/D 979M 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 according to ASTM D 2041/D 2041M, and compacted according to job-mix specifications.
 - 2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726/D 2726M.
 - a. One core sample will be taken for every 1000 sq. yd. (836 sq. m) 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 according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726/D 2726M.
- F. Replace and compact hot-mix asphalt where core tests were taken.
- G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.16 WASTE HANDLING

- A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

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

1. Driveways.
2. Roadways.
3. Parking lots.
4. Curbs and gutters.
5. Walks.

- B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
2. Section 321316 "Decorative Concrete Paving" for stamped concrete other than stamped detectable warnings.
3. 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.
4. Section 321713 "Parking Bumpers."
5. Section 321723 "Pavement Markings."
6. Section 321726 "Tactile Warning Surfacing" for detectable warning mats and pavers.
7. Section 321729 "Manufactured Traffic-Calming Devices."

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 Interfaith Center.

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. Sustainable Design Submittals:
- C. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.
- D. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:
 1. Exposed Aggregate: 10-lb (4.5-kg) Sample of each mix.
- E. 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. Fiber reinforcement.
 4. Admixtures.
 5. Curing compounds.
 6. Applied finish materials.
 7. Bonding agent or epoxy adhesive.
 8. 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. Stamped Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.
- B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M 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").
- C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 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.
- D. 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 mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
 - 2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 96 inches (2400 mm) by 96 inches (2400 mm).
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

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 (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) 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 (ACI 301M) and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) 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 (ACI 301M) 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 (30.5 m) 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 A 1064/A 1064M, fabricated from galvanized steel wire into flat sheets.
- B. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.
- C. Epoxy-Coated Welded-Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.
- D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.

- E. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.
- F. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.
- G. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars; assembled with clips.
- H. Plain-Steel Wire: ASTM A 1064/A 1064M, galvanized.
- I. Deformed-Steel Wire: ASTM A 1064/A 1064M.
- J. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A; coated, deformed.
- K. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.
- L. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars.
- M. Tie Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.
- N. Hook Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), 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.
- O. 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.
- P. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
- Q. Zinc Repair Material: ASTM A 780/A 780M.

2.4 CONCRETE MATERIALS

- A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150/C 150M, color as indicated, portland cement Type II.

2. Fly Ash: ASTM C 618, Class C or Class F.
 3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
 4. Blended Hydraulic Cement: ASTM C 595/C 595M, Type IS, portland blast-furnace slag, Type IP, portland-pozzolan, Type IL, Portland-limestone, Type IT, ternary blended cement.
- B. Normal-Weight Aggregates: ASTM C 33/C 33M, uniformly graded. Provide aggregates from a single source.
1. Maximum Coarse-Aggregate Size: 1 inch nominal.
 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
1. Aggregate Sizes: 1/2 to 3/4 inch (13 to 19 mm) nominal.
 2. Aggregate Source, Shape, and Color: Submitted and approved by owner with sample.
- D. Air-Entraining Admixture: ASTM C 260/C 260M.
- E. 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 C 494/C 494M, Type A.
 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- F. Color Pigment: ASTM C 979/C 979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
1. Color: Match Architect's sample.
- G. Water: Potable and complying with ASTM C 94/C 94M.

2.5 FIBER REINFORCEMENT

- A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches (13 to 38 mm) long.
- B. Synthetic Fiber: Fibrillated polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches (13 to 38 mm) long.

2.6 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, cotton mats.
- B. Moisture-Retaining Cover: ASTM C 171, 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 C 309, Type 1, Class B, dissipating.
- F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.7 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.
- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
- C. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy-Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
 - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch (3 to 6 mm).
- F. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
 - 1. Color: As selected by Architect from manufacturer's full range
- G. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch (9.5-mm) sieve and 85 percent retained on a No. 8 (2.36-mm) sieve.

2.8 STAMPED DETECTABLE WARNING MATERIALS

- A. Detectable Warning Stamp: Semirigid polyurethane mats with formed underside capable of imprinting detectable warning pattern on plastic concrete; perforated with a vent hole at each dome.
 - 1. Size of Stamp: One piece, matching detectable warning area shown on Drawings.
- B. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation designed to facilitate release of stamp mats.

2.9 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), 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. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
 - 1. Fly Ash or Pozzolan: 25 percent.
 - 2. Slag Cement: 50 percent.
 - 3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 - 1. Air Content: 4-1/2 percent plus or minus 1-1/2 percent for 1-1/2-inch (38-mm) nominal maximum aggregate size.
 - 2. Air Content: 4-1/2 percent plus or minus 1-1/2 percent for 1-inch (25-mm) nominal maximum aggregate size.
 - 3. Air Content: 5 percent plus or minus 1-1/2 percent for 3/4-inch (19-mm) nominal maximum aggregate size.
- D. Limit water-soluble, chloride-ion content in hardened concrete to [0.15] [0.30] percent by weight of cement.
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use high-range, water-reducing and retarding 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.

- F. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.5 lb/cu. yd.
- G. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.
- H. Concrete Mixtures: Normal-weight concrete.
 - 1. Compressive Strength (28 Days): 4000 psi (27.6 MPa)
 - 2. Maximum W/C Ratio at Point of Placement: 0.50
 - 3. Slump Limit: 5 inches (125 mm) plus or minus 1 inch (25 mm).

2.10 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M[and ASTM C 1116/C 1116M]. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
 - 1. For concrete batches of 1 cu. yd. (0.76 cu. m) 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. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
 - 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 (5 km/h).
 - 2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).

3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch (13 mm) 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 STEEL REINFORCEMENT INSTALLATION

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 D 3963/D 3963M.

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 (50-mm) 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 (38 mm) 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 (15.25 m) unless otherwise indicated.
 2. Extend joint fillers full width and depth of joint.
 3. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) 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 (6-mm) 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 (75 mm)] <Insert dimension> 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- (3-mm-) 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 (75 mm) 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 (6-mm) 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 (ACI 301M) 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 (ACI 301M) 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 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.
- K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

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. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
 2. 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. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 SPECIAL FINISHES

- A. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:
 1. Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
 2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
 3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
 4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
- B. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of 1/16 inch (1.6 mm).
 1. Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
 2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
 3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.

4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
- C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions and as follows:
1. Uniformly spread 60 lb/100 sq. ft. of dampened, slip-resistive aggregate over paving surface in two applications. Tamp aggregate flush with surface using a steel trowel, but do not force below surface.
 2. Uniformly distribute approximately two-thirds of slip-resistive aggregate over paving surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive aggregate application, uniformly distributing remainder of material at right angles to first application to ensure uniform coverage, and embed by power floating.
 3. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
 4. After curing, lightly work surface with a steel-wire brush or abrasive stone and water to expose nonslip aggregate.
- D. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surface according to manufacturer's written instructions and as follows:
1. Uniformly spread dry-shake hardener at a rate of 100 lb/100 sq. ft. (49 kg/10 sq. m) unless greater amount is recommended by manufacturer to match paving color required.
 2. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
 3. After final power floating, apply a hand-troweled finish followed by a broom finish.
 4. Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

3.9 DETECTABLE WARNING INSTALLATION

- A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Section 321726 "Tactile Warning Surfacing."
1. Tolerance for Opening Size: Plus 1/4 inch (6 mm), no minus.
- B. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Section 321726 "Tactile Warning Surfacing." Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with surrounding concrete paving. Embed tiles in fresh concrete to comply with Section 321726 "Tactile Warning Surfacing" immediately after screeding concrete surface.

3.10 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 (1 kg/sq. m 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 (300-mm) 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 (300 mm), 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.

3.11 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 (ACI 117M) and as follows:
 - 1. Elevation: 3/4 inch (19 mm).
 - 2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
 - 3. Surface: Gap below 10-foot- (3-m-) long; unlevelled straightedge not to exceed 1/2 inch (13 mm).
 - 4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches (13 mm per 300 mm) of tie bar.
 - 5. Lateral Alignment and Spacing of Dowels: 1 inch (25 mm).
 - 6. Vertical Alignment of Dowels: 1/4 inch (6 mm).
 - 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (6 mm per 300 mm) of dowel.

8. Joint Spacing: 3 inches (75 mm).
9. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
10. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.12 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 C 172/C 172M shall be performed according to the following requirements:
 1. Testing Frequency: Obtain at least one composite sample for each 50 cu. yd. 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 C 143/C 143M; 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 C 231/C 231M, 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 C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; 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 (3.4 MPa).
- 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.

3.13 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 32 1373

CONCRETE PAVING JOINT SEALANTS

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. Cold-applied joint sealants.

- B. Related Sections:

- 1. Section 079200 "Joint Sealants" for sealing non-traffic and traffic joints in locations not specified in this Section.
- 2. Section 321313 "Concrete Paving" for constructing joints in concrete pavement.

1.3 PRECONSTRUCTION TESTING

- A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, Samples of materials that will contact or affect joint sealants.

- 1. Testing will not be required if joint-sealant manufacturers submit joint-preparation data that are based on previous testing, not older than 24 months, of sealant products for compatibility with and adhesion to joint substrates and other materials matching those submitted.

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.

- B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

- C. Pavement-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.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Certificates: For each type of joint sealant and accessory, from manufacturer.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for joint sealants.
- D. Preconstruction Compatibility and Adhesion Test Reports: From joint-sealant manufacturer, indicating the following:
 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility with and adhesion to joint sealants.
 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.
- C. Product Testing: Test joint sealants using a qualified testing agency.
 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
- D. Preinstallation Conference: Conduct conference at Project site.

1.7 PROJECT 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 MATERIALS

- A. Compatibility: Provide joint sealants, backing 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.
- B. Colors of Exposed Joint Sealants: Color to match natural concrete (Limestone Gray).

2.2 COLD-APPLIED JOINT SEALANTS

- A. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Sika Corporation USA; Sikaflex -2c SL.
 - b. Pecora Corporation; Urexpam NR-200.

2.3 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are 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 D 5249, 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 D 5249, 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 D 5249; 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.

2.4 PRIMERS

- A. Primers: Product 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.

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 joint-sealant performance.
- 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.
- 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. General: 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 C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install joint-sealant backings of kind indicated 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 backings.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
 - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place joint 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.
- E. Tooling of Non-sag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to 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

- A. Clean off excess joint 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 and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.6 PAVEMENT-JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Joints within cement concrete pavement.
1. Joint Location:
 - a. Expansion and isolation joints in cast-in-place concrete pavement.
 - b. Contraction joints in cast-in-place concrete slabs.
 - c. Other joints as indicated.
 2. Polyurethane Elastomeric Joint Sealant for Concrete: Multicomponent, pourable, self-leveling traffic-grade.
 3. Joint-Sealant Color: Color to match naturally aged concrete (Limestone Gray).

END OF SECTION 321373

SECTION 32 1400

UNIT 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. Bluestone Paving set on a mortar setting bed, with mortared joints over a concrete base layer.
 - 2. Decorative gravel drip edge.
 - 3. Aluminum edge restraints.
- B. Related Sections:
 - 1. Division 32 Section "Concrete Paving" for concrete base under unit pavers and for cast-in-place concrete curbs and gutters.

1.3 REFERENCES

- A. ACI 530.1/ASCE 6/TMS 602: Specifications for Masonry Structures
- B. ASTM A 82: Standard Specification for Steel Wire
- C. ASTM C 119-04: Terminology Relating to Dimension Stone
- D. ASTM A 185: Standard Specification for Steel Welded Wire Reinforcement
- E. ASTM C 1528-08: Standard Guide for Selection of Dimensioned Stone for Exterior Use

1.4 DEFINITIONS

- A. Definitions contained in ASTM C 119 apply to this Section.

1.5 ACTION SUBMITTALS

- A. Product Data: For materials other than water and aggregates.
- B. Product Data: For the following:

1. Bluestone Paving.
 2. Decorative gravel.
 3. Asphalt setting bed materials.
 4. Edge restraints.
- C. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.
- D. Samples:
1. Bluestone paving material.
 2. Decorative gravel.
 3. Joint materials.
 4. Exposed edge restraints.
- E. Qualification Data: Submit qualification data as specified under Article, "Quality Assurance" for the following:
1. Installer
 2. Cementitious materials. Include brand, type, and name of manufacturer.
 3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 4. Grout mixes. Include description of type and proportions of ingredients.
- F. 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 according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of paving, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.
- 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.
- C. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.
- D. Installer Qualifications: An Installer with a minimum of 5 years' experience, who has successfully completed unit paver installation similar in material, design, and extent to that required for this Project.
- E. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Include edge, border conditions and paving patterns.

2. Demonstrate color consistency with mockup; color range shall not exceed range of color established by samples.
3. Mockup shall be a minimum 48"x48" in size.
4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store paving 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.
- B. Pack and load unit pavers for shipment using reasonable care and customary precautions against damage in transit. Do not use material which may cause staining or discoloration for blocking or packing.
- 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 aggregates where grading and other required characteristics can be maintained and contamination avoided.
- E. Store liquids in tightly closed containers protected from freezing.
- F. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- G. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.
- H. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 PROJECT CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
 1. 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.

PART 2 - PRODUCTS

2.1 PAVERS

- A. Bluestone Paving:

1. Manufacturer: PA/NY quarried natural flagging with thermal top surface.
 - a. Color: Blue
 - b. Thickness: 2"
 - c. Size: Based on pattern as shown on plans.
 - d. Finish: Thermal
 - e. Joint Size: 1/8", sand swept joints or mortared for walls.
 2. Setting Bed System: Complying with DDOT SBSS Drawings No. 608.06, 611.20, 611.21, 611.22, 611.24, 611.23, or 611.27 as applicable.
 - a. Setting Base: Concrete base.
 - b. Setting Bed: Bituminous Asphalt with Asphalt tack coat.
 - c. Wall Coping: Mortar setting bed with SS dowel and mortar joints.
- B. Stone Dust Paving
1. Manufacturer: Locally sourced stone fines screening
 - a. C.D. Thomas Co., Inc. or equal., #10 Screenings (Stone Dust)
 - b. Color: blue-gray
- C. Decorative Gravel (Add Alternate No. 15)
1. Manufacturer: Locally sourced, clean/washed stone 3-4" diameter.

2.2 MORTAR AND GROUT SETTING-BED MATERIALS

- A. Regional Materials: Aggregate for mortar and grout, cement, and lime shall be extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.
- B. Portland Cement: ASTM C 150, 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.
- C. Hydrated Lime: ASTM C 207, Type S.
- D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- E. Mortar Cement: ASTM C 1329.
 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Lafarge North America Inc.](#); Lafarge Mortar Cement or Magnolia Superbond Mortar Cement.
 - b. Manufacturers not listed but who do offer products that comply with the requirements of this Section will be considered as substitute manufacturers, subject to the conditions specified in Division 1 Section Product Substitution Procedures.
- F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.
 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Davis Colors](#); True Tone Mortar Colors.

- b. [Lanxess Corporation](#); Bayferrox Iron Oxide Pigments.
 - c. [Solomon Colors, Inc.](#); SGS Mortar Colors.
- G. Colored Cement Product: Packaged blend made from portland cement and hydrated lime or mortar cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.
- 1. Colored Portland Cement-Lime Mix:
 - a. **Products:** Subject to compliance with requirements, provide one of the following:
 - 1) [Capital Materials Corporation](#); Riverton Portland Cement Lime Custom Color.
 - 2) [Holcim \(US\) Inc.](#); Rainbow Mortamix Custom Color Cement/Lime.
 - 3) [Lafarge North America Inc.](#); Eaglebond Portland & Lime.
 - 4) [Lehigh Cement Company](#); Lehigh Custom Color Portland/Lime Cement.
 - 2. Colored Masonry Cement:
 - a. **Products:** Subject to compliance with requirements, provide one of the following:
 - 1) [Capital Materials Corporation](#); Flamingo Color Masonry Cement.
 - 2) [Cemex S.A.B. de C.V.](#); Richcolor Masonry Cement.
 - 3) [Essroc, Italcementi Group](#); Brixment-in-Color.
 - 4) [Holcim \(US\) Inc.](#); Rainbow Mortamix Custom Color Masonry Cement.
 - 5) [Lafarge North America Inc.](#); U.S. Cement Custom Color Masonry Cement.
 - 6) [Lehigh Cement Company](#); Lehigh Custom Color Masonry Cement.
 - 7) [National Cement Company, Inc.](#); Coosa Masonry Cement.
 - 3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
 - 4. Pigments shall not exceed 10 percent of portland cement by weight.
 - 5. Pigments shall not exceed 5 percent of mortar cement by weight.
- H. Aggregate for Mortar: ASTM C 144.
- 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.
- I. Aggregate for Grout: ASTM C 404.
- J. Epoxy Pointing Mortar: ASTM C 395, epoxy-resin-based material formulated for use as pointing mortar for structural-clay tile facing units (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's colors.
- K. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
- 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Euclid Chemical Company \(The\)](#); Accelguard 80.
 - b. [Grace Construction Products, W. R. Grace & Co. - Conn.](#); Morset.
 - c. [Sonneborn Products, BASF Aktiengesellschaft](#); Trimix-NCA.
- L. Water: Potable.

2.3 EDGE RESTRAINTS

- A. Natural Aluminum Edge Restraints (for bluestone and stone dust): Manufacturer's black Duraflex-Electrostatic finish aluminum edging, 2" x 2.25" with loops pressed from face to receive stakes. Color shall be black.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Permaloc Aluminum Edging, 13505 Barry Street Holland, MI, 49424, (800) 356-9660. AsphaltEdge 2" x 2.25" MF black finish.

2.4 ACCESSORIES

- A. Compressible Foam Filler: Preformed strips complying with ASTM D 1056, Grade 2A1.
- B. Stainless steel dowels, ½" diameter.
- C. Attach aluminum edging with 3/8" x 10" spiral steel spike or with Hilti 1 ½" x 2 ½" Nails at 12" on center if into a concrete or asphalt subbase.

2.5 EXAMINATION

- A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

2.6 PREPARATION

- A. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.
- B. Proof-roll prepared subgrade according to requirements in Division 31 Section "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for unit pavers.

2.7 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

- C. Cut paving with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
- D. Joint Pattern: As indicated.
- E. Tolerances:
 - 1. Pavers. Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.
 - 2. Ensure that a minimum 2% cross slope for positive drainage results from the installation of the paver system. Positive drainage must also be held in all accessible pathways.
- F. Expansion and Control Joints: Provide joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of concrete base. Do not extend joint filler to finish grade.
- G. Provide edge restraints as indicated. Install edge restraints before placing pavers.
 - 1. Install edge restraints to comply with manufacturer's written instructions where applicable. Install stakes or anchors at intervals required to hold edge restraints in place during and after unit paver installation.

2.8 MORTAR SETTING-BED APPLICATIONS

- A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
- B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch (1.6-mm) thickness for bond coat.
- C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
- D. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.
- E. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch- (1.5-mm-) thick bond coat to back of each paver with a flat trowel.
- F. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
- G. Spaced Joint Widths: Provide 1/2-inch nominal joint width with variations not exceeding plus or minus 1/8 inch.
- H. Grouted Joints: Grout paver joints complying with ANSI A108.10.

- I. Grout joints as soon as possible after initial set of setting bed.
 - 1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
 - 2. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
 - 3. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
 - 4. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.
- J. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

2.9 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Monitor joint filler for settlement and replenish if joints settle to more than 1/4" below finish paved surface.
- C. Cleaning: Remove excess sand from exposed paver surfaces; wash and scrub clean.

END OF SECTION 321400

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 painted markings applied to asphalt and concrete pavement.
- B. Related Requirements:
 - 1. Section 071800 "Traffic Coatings" for painting whole areas of building floors and pavements with coatings having an integral wearing surface.
 - 2. Section 099113 "Exterior Painting" for painting exterior concrete surfaces other than pavement.
 - 3. Section 099123 "Interior Painting" for painting interior concrete surfaces other than pavement.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Interfaith Center.
 - 1. Review methods and procedures related to marking pavement including, but not limited to, the following:
 - a. Pavement 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: For each type of product.
 - 1. Include technical data and tested physical and performance properties.
- B. Shop Drawings: For pavement markings.
 - 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.

- C. Samples: For each exposed product and for each color and texture specified; on rigid backing, 8 inches (200 mm) square.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of <Insert applicable standards> of <Insert name of state or local DOT> 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 (12.8 deg C) for water-based materials, and not exceeding 95 deg F (35 deg C).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in ICC A117.1

2.3 PAVEMENT-MARKING PAINT

- A. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N; colors complying with FS TT-P-1952.
 - 1. Color: As indicated.
- B. Pavement-Marking Paint: MPI #32, solvent-borne traffic-marking paint.
 - 1. Color: As indicated.
- C. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than [three] [45] minutes.
 - 1. Color: As indicated.
- D. Pavement-Marking Paint: MPI #97, latex traffic-marking paint.
 - 1. Color: As indicated

- E. Glass Beads: AASHTO M 247, Type 1.
 - 1. Roundness: Minimum 80 percent true spheres by weight.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that pavement is dry and in suitable condition to begin pavement marking according to 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 paving 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 (0.4 mm).
 - 1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to pavement. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
 - 2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal. (0.72 kg/L).

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 32 9100
PLANTING SOIL

PART 1 – GENERAL

1.1 SUMMARY

- A. The scope of work includes all labor, materials, tools, supplies, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation of Planting Soil and /or the modification of existing site soil for use as Planting Soil, complete as shown on the drawings and as specified herein. The Planting Soil as specified below is to be used for tree, shrub, perennials, groundcover beds and for seeded and sodded lawn areas.
- B. The scope of work in this section includes, but is not limited to, the following:
 - 1. Locate, purchase, deliver and install Imported Planting Soil and soil amendments.
 - 2. Harvest and stockpile existing site soils suitable for Planting Soil.
 - 3. Modify existing stockpiled site soil.
 - a. Modify existing site soil in place for use as Planting Soil.
 - b. Install existing or modified existing soil for use as Planting Soil.
 - 4. Locate, purchase, deliver and install subsurface Drain Lines.
 - 5. Fine grade Planting Soil.
 - 6. Add and incorporate Compost into site soils or imported soils for achieving specified Planting Soil requirements.
 - 7. Clean up and disposal of all excess and surplus material.

1.2 CONTRACT DOCUMENTS

- A. Shall consist of specifications, general conditions, and the drawings. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any parts shall be as binding as if called for in all parts.

1.3 RELATED DOCUMENTS AND REFERENCES

- A. Related Documents:
 - 1. Drawings and general provisions of contract, including general and supplementary conditions and Division I specifications, apply to work of this section.
 - 2. Related Specification Section
 - a. Section 32 Section 9300 for "Planting".
 - b. Section 32 Section 8000 for "Irrigation".
 - c. Section 32 Section 9200 for "Turfs and Grasses".
 - d. Section 01 Section 5639 for "Tree Protection".
- B. References: The following specifications and standards of the organizations and documents

listed in this paragraph form a part of the Specification to the extent required by the references thereto. In the event that the requirements of the following referenced standards and specification conflict with this specification section the requirements of this specification shall prevail. In the event that the requirements of any of the following referenced standards and specifications conflict with each other the more stringent requirement shall prevail.

1. ASTM: American Society of Testing Materials cited section numbers.
2. U.S. Department of Agriculture, Natural Resources Conservation Service, 2003. National Soil Survey Handbook, title 430-VI. Available Online.
3. US Composting Council *www.compostingcouncil.org* and http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/191/LandscapeArch_Specs.pdf.
4. *Methods of Soil Analysis*, as published by the Soil Science Society of America (<http://www.soils.org/>).
5. Up by Roots: healthy soils and trees in the built environment. 2008. J. Urban. International Society of Arboriculture, Champaign, IL.

1.4 VERIFICATION

- A. All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions and quantities, and shall immediately inform the Owner's Representative of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given approval to do so by the Owner's Representative.

1.5 PERMITS AND REGULATIONS

- A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owner's Representative in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.
- B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.
- C. In case of conflict among any referenced standards or codes or among any referenced standards and codes and the specifications, the more restrictive standard shall apply or Owner's Representative shall determine which shall govern.

1.6 PROTECTION OF WORK, PROPERTY AND PERSON

- A. The Contractor shall adequately protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to the Contractor's actions.

1.7 CHANGES IN WORK

- A. The Owner's Representative may order changes in the work, and the contract sum adjusted accordingly. All such orders and adjustments plus claims by the Contractor for extra

compensation must be made and approved in writing before executing the work involved.

- B. All changes in the work, notifications and contractor's request for information (RFI) shall conform to the contract general condition requirements.

1.8 CORRECTION OF WORK

- A. The Contractor shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Owner's Representative, at the soonest possible time that can be coordinated with other work and seasonal weather demands but not more than 180 (one hundred and eighty) days after notification.

1.9 DEFINITIONS

- A. Acceptable drainage: Drainage rate is sufficient for the plants to be grown. Not too fast and not too slow. Typical rates for installed Planting Soil are between 1 - 5 inches per hour. Turf soils are often higher, but drainage rates above 2 - 3 inches per hour will dry out very fast. In natural undisturbed soil a much lower drainage rate, as low as 1/8th inch per hour can still support good plant growth. Wetland plants can grow on top of perched water layers or even within seasonal perched water layers, but could become unstable in high wind events.
- B. Amendment: material added to Topsoil to produce Planting Soil Mix. Amendments are classified as general soil amendments, fertilizers, biological, and pH amendments.
- C. Biological Amendment: Amendments such as Mycorrhizal additives, compost tea or other products intended to change the soil biology.
- D. Compacted soil: soil where the density of the soil is greater than the threshold for root limiting, and further defined in this specification.
- E. Compost: well decomposed stable organic material as defined by the US Composting Council and further defined in this specification.
- F. Drainage: The rate at which soil water moves through the soil transitioning the soil from saturated condition to field capacity. Most often expressed as saturated hydraulic conductivity (Ksat; units are inches per hour).
- G. End of Warranty Acceptance: The date when the Owner's Representative accepts that the plants and work in this section meet all the requirements of the warranty. It is intended that the materials and workmanship warranty for Planting, Planting Soil, and Irrigation (if applicable) work run concurrent with each other, and further defined in this specification.
- H. Existing Soil: Mineral soil existing at the locations of proposed planting after the majority of the construction within and around the planting site is completed and just prior to the start of work to prepare the planting area for soil modification and/or planting, and further defined in this specification.
- I. Fertilizer: amendment used for the purpose of adjusting soil nutrient composition and balance.
- J. Fine grading: The final grading of the soil to achieve exact contours and positive drainage, often accomplished by hand rakes or drag rakes or other suitable devices, and further defined in this specification, and further defined in this specification.
- K. Finished grade: surface or elevation of Planting Soil after final grading and 12 months of settlement of the soil, and further defined in this specification.

- L. Graded soil: Soil where the A horizon has been stripped and relocated or re-spread; cuts and fills deeper than 12 inches, and further defined in this specification.
- M. Installed soil: Planting soil and existing site soil that is spread and or graded to form a planting soil, and further defined in this specification.
- N. Minor disturbance: Minor grading as part of agricultural work that only adjusts the A horizon soil, minor surface compaction in the top 6 inches of the soil, applications of fertilizers, installation of utility pipes smaller than 18 inches in diameter thru the soil zone.
- O. Owner's Representative: The person or entity, appointed by the Owner to represent their interest in the review and approval of the work and to serve as the contracting authority with the Contractor. The Owner's Representative may appoint other persons to review and approve any aspects of the work.
- P. Ped: a clump or clod of soil held together by a combination of clay, organic matter, and fungal hyphae, retaining the original structure of the harvested soil.
- Q. Planting Soil: Topsoil, or Planting Soil Mixes which are imported or existing at the site, or made from components that exist at the site, or are imported to the site; and further defined in this specification.
- R. *Poor drainage: Soil drainage that is slower than that to which the plants can adapt. This is a wide range of metrics, but generally if the soil is turning grey in color it is reasonable preferable to either to plant moisture adaptive plants at smaller sizes that are young in age with shallow root balls or look at options to improve the drainage*
- S. Scarify: Loosening and roughening the surface of soil and sub soil prior to adding additional soil on top, and further defined in this specification.
- T. Soil Fracturing: Deep loosening the soil to the depths specified by using a back hoe, and further defined in this specification.
- U. Soil Horizons: as defined in the USDA National Soil Survey Handbook
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242.
- V. Soil Ripping: Loosening the soil by dragging a ripping shank or chisel thru the soil to the depths and spacing specified, and further defined in this specification.
- W. Soil Tilling: Loosening the surface of the soil to the depths specified with a rotary tine tilling machine, roto tiller, (or spade tiller), and further defined in this specification.
- X. Soil trenching: Cutting narrow trenches thru the soil at the depths and spacing specified to loosen the soil profile, and further defined in this specification.
- Y. Subgrade: surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing Planting Soil.
- Z. Substantial Completion Acceptance: The date at the end of the Planting, Planting Soil, and Irrigation installation (if applicable) where the Owner's Representative accepts that all work in these sections is complete and the Warranty period has begun. This date may be different than the date of substantial completion for the other sections of the project, and further defined in this specification.
- AA. Topsoil: naturally produced and harvested soil from the A horizon or upper layers or the soil as further defined in this specification.
- BB. Undisturbed soil: Soils with the original A horizon intact that have not been graded or

compacted. Soils that have been farmed, subjected to fire or logged but not graded, and natural forested land will be considered as undisturbed.

1.10 SUBMITTALS

- A. See the contract General Conditions for policy and procedures related to submittals.
- B. Submit all product submittals eight weeks prior to the start of the soil work.
- C. Product data and certificates: For each type of manufactured product, submit data and certificates that the product meets the specification requirements, signed by the product manufacturer, and complying with the following:
 - 1. Submit manufacturers or supplier's product data and literature certified analysis for standard products and bulk materials, complying with testing requirements and referenced standards and specific requested testing.
 - a. For each Compost product submit the following analysis by a recognized laboratory:
 - 1.) pH
 - 2.) Salt concentration (electrical conductivity)
 - 3.) Moisture content %, wet weight basis
 - 4.) Particle size % passing a selected mesh size, dry weight basis
 - 5.) Stability carbon dioxide evolution rate mg CO₂-C per g OM per day
 - 6.) Solvita maturity test
 - 7.) Physical contaminants (inerts) %, dry weight basis
 - 8.) US EPA Class A standard, 40CFR § 503.13, Tables 1 and 3 levels Chemical Contaminants mg/kg (ppm)
 - b. For Coarse Sand product submit the following analysis by a recognized laboratory:
 - 1.) pH
 - 2.) Particle size distribution (percent passing the following sieve sizes):
 - 3/8 inch (9.5 mm)
 - No 4 (4.75 mm)
 - No 8 (2.36 mm)
 - No 16(1.18 mm)
 - No 30 (.60 mm)
 - No 50 (.30 mm)
 - No 100 (.15 mm)
 - No 200 (.075 mm)
- D. Samples: Submit samples of each product and material, where required by Part 2 of the specification, to the Owner's Representative for approval. Label samples to indicate product, characteristics, and locations in the work. Samples will be reviewed for appearance only.
 - 1. Submit samples a minimum of 8 weeks prior to the anticipated date of the start of soil installation.
 - 2. Samples of all Topsoil, Coarse Sand, Compost and Planting Soil shall be submitted at the same time as the particle size and physical analysis of that material.
- E. Soil testing for Imported and Existing Topsoil, existing site soil to be modified as Planting Soil and Planting Soil Mixes.
 - 1. Topsoil, existing site soil and Planting Soil Mix testing: Submit soil test analysis report for each sample of Topsoil, existing site soil and Planting Soil from an approved soil-testing laboratory and where indicated in Part 2 of the specification as follows:

- a. Submit Topsoil, Planting Soil, Compost, and Coarse Sand for testing at least 8 weeks before scheduled installation of Planting Soil Mixes. Submit Planting Soil Mix test no more than 2 weeks after the approval of the Topsoil, Compost and Coarse Sand. Do not submit to the testing laboratory, Planting Soil Mixes, for testing until all Topsoil, Compost and Coarse Sand have been approved.
 - b. If tests fail to meet the specifications, obtain other sources of material, retest and resubmit until accepted by the Owner's Representative.
 - c. All soil testing will be at the expense of the Contractor.
2. Provide a particle size analysis (% dry weight) and USDA soil texture analysis. Soil testing of Planting Soil Mixes shall also include USDA gradation (percentage) of gravel, coarse sand, medium sand, and fine sand in addition to silt and clay.
 3. Provide the following other soil properties:
 - a. pH and buffer pH.
 - b. Percent organic content by oven dried weight.
 - c. Nutrient levels by parts per million including: phosphorus, potassium, magnesium, manganese, iron, zinc and calcium. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the soil for optimum growth of the plantings specified.
 - d. Soluble salt by electrical conductivity of a 1:2 soil water sample measured in Milliohm per cm.
 - e. Cation Exchange Capacity (CEC).

1.11 SOIL INSTALLATION MOCKUP

- A. Prior to installation or modification of Topsoil, site soil, Planting Soil, or Planting Soil Mixes, construct at the site, a mockup of each soil type using the means and methods and equipment proposed by the Contractor to complete the work. Installation of the mockup shall be in the presence of the Owner's Representative. The purpose of the mockup is to test the methods of installation and compaction of the soil and to serve as a benchmark for completed soil compaction and serve to calibrate penetrometer readings to the known proctor density of the mockup. The mockup shall be as follows:
 1. Following acceptance of the soil submittals, in areas that can be protected from disturbance and further compaction, install mockups of each soil type and soil modification, 20 foot X 20 foot X the full depth of the deepest installation, using the requirements of these specifications. Compaction methods, including the type of compaction equipment and number of passes required to achieve the required compaction, shall be evaluated and results measured.
 2. Compaction in the mockup soil shall be tested using the penetrometer. A minimum of four penetrometer readings from each Planting Soil shall be taken at the specified depths of the soil profile. Record the soil moisture at each penetrometer test site. In the event that the penetrometer readings exceed the specified densities, reconstruct the mockup, adjusting the soil density to achieve the desired results. Where the modification requires ripping, tilling or fracturing soils that are over compacted, start the procedure in a new location so that the process is working on soil that is similar to the density of the expected soil.
 3. Submit a report of the final methods of soil installation, the penetrometer and soil moisture readings to the Owner's Representative.
 4. The mockup area may remain as part of the installed work at the end of the project if

protected from further compaction, contamination or other disturbance.

5. Provide a protective 4 foot high fence on metal posts around each mockup to keep all work and equipment from entering the surface of the mockup area.

1.12 OBSERVATION OF THE WORK

- A. The Owner's Representative may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
 1. The Owner's Representative may utilize the Contractor's penetrometer and moisture meter at any time to check soil compaction and moisture.
- B. The Owner's Representative shall be informed of the progress of the work so the work may be observed at the following key times in the construction process. The Owner's Representative shall be afforded sufficient time to schedule visit to the site. Failure of the Owner's Representative to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.
 1. SOIL MOCKUP REVIEW: At the time of construction of all soil mockups.
 2. EXISTING SOIL CONDITIONS REVIEW: Prior to the start of any soil modification that will utilize or modify the existing soil.
 3. EXCAVATION REVIEW: Observe each area of excavation prior to the installation of any Planting Soil.
 4. DRAIN LINE INSTALLATION REVIEW: Upon completion of the installation of drain lines and prior to the installation of any Planting Soil
 5. COMPLETION of SOIL MODIFICATIONS REVIEW: Upon completion of all soil modification and installation of planting soil.
 6. COMPLETION OF FINE GRADING AND SURFACE SOIL MODIFICATIONS REVIEW: Upon completion of all surface soil modifications and fine grading but prior to the installation of shrubs, ground covers, or lawns.

1.13 PRE-CONSTRUCTION CONFERENCE

- A. Schedule a pre-construction meeting with the Owner's Representative at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction and project work schedule.

1.14 QUALITY ASSURANCE

- A. Installer Qualifications: The installer shall be a firm having at least 5 years of experience of a scope similar to that required for the work, including the preparation, mixing and installation of soil mixes to support planting. The installer of the work in Section: Planting, shall be the same firm installing the work in this section.
 1. The bidders list for work under this section shall be approved by the Owner's Representative.
 2. Installer Field Supervision: When any Planting Soil work is in progress, installer shall maintain, on site, an experienced full-time supervisor who can communicate in English

- with the Owner's Representative.
3. Installer's field supervisor shall have a minimum of five years' experience as a field supervisor installing soil, shall be trained and proficient in the use of field surveying equipment to establish grades and can communicate in English with the Owner's Representative.
 4. The installer's crew shall be experienced in the installation of Planting Soil, plantings, and irrigation (where applicable) and interpretation of planting plans, soil installation plans, and irrigation plans (where applicable).
 5. Submit references of past projects and employee training certifications that support that the Contractors meet all of the above installer qualifications and applicable licensures.
- B. Soil testing laboratory qualifications: an independent laboratory, with the experience and capability to conduct the testing indicated and that specializes in USDA agricultural soil testing, Planting Soil Mixes, and the types of tests to be performed. Geotechnical engineering testing labs shall not be used.
- C. All delivered and installed Planting Soil shall conform to the approved submittals sample color, texture and approved test analysis.
1. The Owner's Representative may request samples of the delivered or installed soil be tested for analysis to confirm the Planting Soil conforms to the approved material.
 2. All testing shall be performed by the same soil lab that performed the original Planting Soil testing.
 3. Testing results shall be within 10% plus or minus of the values measured in the approved Planting Soil Mixes.
 4. Any Planting Soil that fails to meet the above criteria, if requested by the Owner's Representative, shall be removed and new soil installed.
- D. Soil compaction testing: following installation or modification of soil, test soil compaction with a penetrometer.
1. Maintain at the site at all times a soil cone penetrometer with pressure dial and a soil moisture meter to check soil compaction and soil moisture.
 - a. Penetrometer shall be AgraTronix Soil Compaction Meter distributed by Ben Meadows, www.benmeadows.com or approved equal.
 - b. Moisture meter shall be "general digital soil moisture meter" distributed by Ben Meadows, www.benmeadows.com or approved equal.
 2. Prior to testing the soil with the penetrometer check the soil moisture and penetrometer readings in the mockup soils. Penetrometer readings are impacted by soil moisture and excessively wet or dry soils will read significantly lower or higher than soils at optimum moisture.
 3. The penetrometer readings shall be within 20% plus or minus of the readings in the approved mockup when at similar moisture levels.

1.15 SITE CONDITIONS

- A. It is the responsibility of the Contractor to be aware of all surface and subsurface conditions, and to notify the Owner's Representative, in writing, of any circumstances that would negatively impact the health of plantings. Do not proceed with work until unsatisfactory conditions have been corrected.

1. Should subsurface drainage or soil conditions be encountered which would be detrimental to growth or survival of plant material, the Contractor shall notify the Owner's Representative in writing, stating the conditions and submit a proposal covering cost of corrections. If the Contractor fails to notify the Owner's Representative of such conditions, they shall remain responsible for plant material under the warrantee clause of the specifications.
2. This specification requires that all Planting Soil and Irrigation (if applicable) work be completed and accepted prior to the installation of any plants or seeded or sodded lawns.

1.16 SOIL COMPACTION – GENERAL REQUIREMENTS

- A. Except where more stringent requirements are defined in this specification. The following parameters shall define the general description of the threshold points of soil compaction in existing, modified or installed soil and subsoil.
- B. The following are threshold levels of compaction as determined by each method.
 1. Acceptable Compaction: Good rooting anticipated, but increasing settlement expected as compaction is reduced and/or in soil with a high organic matter content.
 - a. Bulk Density Method – Varies by soil type see Chart on page 32 in Up By Roots.
 - b. Standard Proctor Method – 75-85%; soil below 75% is unstable and will settle excessively.
 - c. Penetration Resistance Method – about 75-250 psi, below 75 psi soil becomes increasingly unstable and will settle excessively.
 2. Root limiting Compaction: Root growth is limited with fewer, shorter and slower growing roots.
 - a. Bulk Density Method – Varies by soil type see Chart on page 32 in Up By Roots.
 - b. Standard Proctor Method – above approximately 85%.
 - c. Penetration Resistance Method – about 300 psi.
 3. Excessive Compaction: Roots not likely to grow but can penetrate soil when soil is above field capacity.
 - a. Bulk Density Method – Varies by soil type see Chart on page 32 in Up By Roots.
 - b. Standard Proctor Method – Above 90%.
 - c. Penetration Resistance Method – Approximately above 400 psi

1.17 DELIVERY, STORAGE, AND HANDLING

- A. Weather: Do not mix, deliver, place or grade soils when frozen or with moisture above field capacity.
- B. Protect soil and soil stockpiles, including the stockpiles at the soil blender's yard, from wind, rain and washing that can erode soil or separate fines and coarse material, and contamination by chemicals, dust and debris that may be detrimental to plants or soil drainage. Cover stockpiles with plastic sheeting or fabric at the end of each workday.
- C. All manufactured packaged products and material shall be delivered to the site in unopened containers and stored in a dry enclosed space suitable for the material and meeting all environmental regulations. Biological additives shall be protected from extreme cold and heat. All products shall be freshly manufactured and dated for the year in which the products are to be used.
- D. Deliver all chemical amendments in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in a weather

protected enclosure.

- E. Bulk material: Coordinate delivery and storage with Owner's Representative and confine materials to neat piles in areas acceptable to Owner's Representative.
- F. The maximum stockpile depth for planting soils is 6 feet and preferably 3 feet for maintaining the soils existing healthy structure/properties.

1.18 EXCAVATING AND GRADING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavate as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of the Miss Utility Maryland (800) 257-7777, is required for all planting areas. The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the local utility locator service.

PART 2 – PRODUCTS

2.1 IMPORTED AND SALVAGED ON-SITE TOPSOIL

- A. Imported and salvaged on-site Topsoil definition: Fertile, friable soil containing less than 5% total volume of the combination of subsoil, refuse, roots larger than 1 inch diameter, heavy, sticky or stiff clay, stones larger than 2 inches in diameter, noxious seeds, sticks, brush, litter, or any substances deleterious to plant growth. The percent (%) of the above objects shall be controlled by source selection not by screening the soil. Topsoil shall be suitable for the germination of seeds and the support of vegetative growth. Imported and salvaged on-site Topsoil shall not contain weed seeds in quantities that cause noticeable weed infestations in the final planting beds or lawn areas. Imported and salvaged on-site Topsoil shall meet the following physical and chemical criteria:
 - 1. Soil texture: USDA loam, sandy clay loam or sandy loam with clay content between 15 and 25%. And a combined clay/silt content of no more than 55%.
 - 2. pH value shall be between 5.5 and 7.0.
 - 3. Percent organic matter (OM): 2.0-5.0%, by dry weight.
 - 4. Soluble salt level: Less than 2 mmho/cm.
 - 5. Soil chemistry suitable for growing the plants specified.
- B. Imported and salvaged on-site Topsoil shall be a harvested soil from fields, development sites or from the project site areas as allowable. The organic content and particle size distribution shall be the result of natural soil formation. Manufactured soils where Coarse Sand, Composted organic material or chemical additives has been added to the soil to meet the requirements of this specification section shall be acceptable. Retained soil peds shall be the same color on the inside as is visible on the outside.
- C. Imported and salvaged on-site Topsoil for Planting Soil shall NOT have been screened and shall retain soil peds or clods larger than 2 inches in diameter throughout the stockpile after

harvesting.

- D. Provide a two gallon sample from each Imported and salvaged on-site Topsoil source with required soil testing results. The sample shall be a mixture of the random samples taken around the source stockpile or field. The soil sample shall be delivered with soil peds intact that represent the size and quantity of expected peds in the final delivered soil.

2.2 COMPOST

- A. Compost: Blended and ground leaf, wood and other plant based material, composted for a minimum of 9 months and at temperatures sufficient to break down all woody fibers, seeds and leaf structures, free of toxic material at levels that are harmful to plants or humans. Source material shall be yard waste trimmings blended with other plant or manure based material designed to produce Compost high in fungal material.
 - 1. Compost shall be commercially prepared Compost and meet US Compost Council STA/TMECC criteria or as modified in this section for "Compost as a Landscape Backfill Mix Component".
http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/191/LandscapeArch_Specs.pdf
 - 2. Compost shall comply with the following parameters:
 - a. pH: 5.5 - 8.0.
 - b. Soil salt (electrical conductivity): maximum 5 dS/m (mmhos/cm).
 - c. Moisture content %, wet weight basis: 30 – 60.
 - d. Particle size, dry weight basis: 98% pass through 3/4 inch screen or smear.
 - e. Stability carbon dioxide evolution rate: mg CO₂-C/ g OM/ day < 2.
 - f. Solvita maturity test: > 6.
 - g. Physical contaminants (inerts), %, dry weight basis: <1%.
 - h. Chemical contaminants, mg/kg (ppm): meet or exceed US EPA Class A standard, 40CFR § 503.13, Tables 1 and 3 levels.
 - i. Biological contaminants select pathogens fecal coliform bacteria, or salmonella, meet or exceed US EPA Class A standard, 40 CFR § 503.32(a) level requirements.
- B. Provide a two gallon sample with manufacturer's literature and material certification that the product meets the requirements.

2.3 COARSE SAND

- A. Clean, washed, sand, free of toxic materials
 - 1. Coarse concrete sand, ASTM C-33 Fine Aggregate, with a Fines Modulus Index of 2.8 and 3.2.
 - 2. Coarse Sands shall be clean, sharp, natural Coarse Sands free of limestone, shale and slate particles. Manufactured Coarse Sand shall not be permitted.
 - 3. pH shall be lower than 7.0.
 - 4. Provide Coarse Sand with the following particle size distribution:

Sieve	Percent passing
3/8 inch (9.5 mm)	100
No 4 (4.75 mm)	95-100
No 8 (2.36 mm)	80-100
No 16 (1.18 mm)	50-85

No 30 (.60 mm)	25-60
No 50 (.30 mm)	10-30
No 100 (.15 mm)	2-10
No 200 (0.75 mm)	2-5

- B. Provide a two gallon sample with manufacturer's literature and material certification that the product meets the requirements.

2.4 LIME

- A. ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
 - 1. Class: Class T, with a minimum 99 percent passing through No. 8 (2.36-mm) sieve and a minimum 75 percent passing through No. 60 (0.25-mm) sieve.
 - 2. Provide lime in form of dolomitic limestone.
- B. Provide manufacturer's literature and material certification that the product meets the requirements.

2.5 EXISTING SOIL (Acceptable for planting with minimum modifications)

- A. General definition of existing soil: Surface soil in the areas designated on the soils plan as existing soil, that is not altered, compacted to root limiting density, graded or contaminated before or during the construction process and considered acceptable for planting and long term health of the plants specified either as it exists or with only minor modification.
 - 1. The Owner's Representative shall verify that the soil in the designated areas is suitable at the beginning of planting bed preparation work in that area. In the event that the work of this project construction has damaged the existing soil in areas designated for use as Planting Soil to the point where the soil is no longer suitable to support the plants specified, the Owner's Representative may require modification of the damaged soil up to and including removal and replacement with soil of equal quality to the soil that existed prior to construction. Examples of damage include further compaction, contamination, grading, creation of hard pan or drainage problems, and loss of the O, and or A horizon.
 - a. Do not begin work on additional modifications until changes to the contract price are approved by Owner's Representative.
 - 2. Soil testing results and soil observation notes that describe the pre-construction soil conditions in the existing soil areas are included as an appendix to this specification:
- B. Protect existing soil from compaction, contamination, and degradation during the construction process.
- C. Unless otherwise instructed, remove all existing plants, root thatch, and non-soil debris from the surface of the soil using equipment that does not increase compaction of soil to root limiting levels.
- D. Modifications:
 - 1. When results of soil tests recommend chemical adjustments, till surface soil to six inches or greater after chemical adjustments have been applied.
 - 2. Remove existing turf thatch, ground cover plants and weeds.
 - 3. Provide pre-emergent weed control if indicated.

4. Make chemical adjustment as recommended by the soil test.

2.6 MODIFIED EXISTING SOIL (SOIL SUITABLE FOR PLANTING WITH INDICATED MODIFICATION)

- A. General definition: Surface soil in the areas designated on the soils plan as Modified Existing Soil has been altered and or graded before or during the construction process but is still considered acceptable for planting and long term health of the plants specified with the proposed modifications. Modifications respond to the soil problems expected or encountered. The Owner's Representative shall verify that the soil in the designated areas is suitable for modification at the beginning of planting bed preparation work in that area.
 1. The Owner's Representative shall verify that the soil in the designated areas is suitable for the specified modification at the beginning of planting bed preparation work in that area. In the event that the work of this project construction has damaged the existing soil in areas designated for modification to the point where the soil is no longer suitable to support the plants specified with the specified modification, the Owner's Representative may require further modification of the damaged soil up to an including removal and replacement with soil of equal quality to the soil that would have resulted from the modification. Damage may include further compaction, contamination, grading, creation of hard pan or drainage problem, and loss of the O, and or A horizon.
 2. General requirements for all soil modifications:
 - a. Take soil samples, test for chemical properties, and make appropriate adjustments.
 - b. Unless otherwise instructed, remove all existing plants, root thatch, and non-soil debris from the surface of the soil using equipment that does not add to the compaction in the soil.
 - c. All soil grading, tilling and loosening must be completed at times when the soil moisture is below field capacity. Allow soil to drain for at least two days after any rain event more than 1 inch in 24 hours, or long enough so that the soil does not make the hand muddy when squeezed.
 - d. Provide pre-emergent weed control after the soil work is complete and plants planted but prior to adding mulch to the surface, if indicated by weed type and degree of threat.
- B. Modified existing soil – soil removed, stockpiled, and spread
 1. Description of condition to be modified: Existing soil that is suitable for reuse as Planting Soil but is in the wrong place of elevation, or cannot be adequately protected during construction. Soil is to be harvested, stockpiled and re-spread with or without further modifications as indicated.
 2. Modifications:
 - a. Excavate existing soil from the areas and to depths designated on the drawings. Stockpile in zones noted on the drawings or in areas proposed by the Contractor.
 - 1.) Prepare a soil stock pile plan for approval.
 - b. Excavate soil using equipment and methods to preserve the clumps and peds in the soil. Generally this means using the largest piece of equipment that is practical for the project size and scope.
 - c. Protect stock piles from erosion by compacting or tracking the soil surface, covering with breathable fabric or planting with annual grasses as appropriate for the season, location, and length of expected time of storage.
 - d. Re-spread soil as required in Part 3 of this specification.

- C. Modified existing soil – compacted surface soil (Tilling Option)
1. Description of condition to be modified: Surface soil compaction to a maximum of 6 inches deep from traffic or light grading. Original A horizon may be previously removed or graded but lower profile intact with acceptable compaction levels and limited grading. The soil organic matter, pH and chemistry in the A horizon may not be suitable for the proposed plants and may need to be modified as required.
 2. Modifications:
 - a. Till top 6 inches or deeper of the soil surface, with a *roto tiller*, *spade tiller*, ripper or agricultural plow. Spread 2 - 3 inches of Compost on the surface of the tilled soil and make any chemical adjustment as recommended by the soil test.
 - b. Till or disk the Compost into the loosened soil. Smooth out grades with a drag rake or drag slip.
- D. Modified existing soil – compacted surface soil (Radial Trenching Option)
1. Description of condition to be modified: Surface soil compaction to a maximum of 24 inches deep from traffic or light grading. Original A horizon may be previously removed or graded but lower profile below 24 inches intact with acceptable compaction levels and limited grading. The soil organic matter, pH and chemistry in the A horizon may not be suitable for the proposed plants and may need to be modified as required.
 2. Modifications:
 - a. Using a trenching machine, dig trenches to the extent and depth shown on the plans and details.
 - b. Backfill the trench with the soil removed from the trench. Add additional site soil if needed to fill the trench to be flush to the existing grade after the soil settlement.
- E. Modified existing soil – compacted subsoil
1. Description of condition to be modified: Deep soil compaction the result of previous grading, filling and dynamic or static compaction forces. Original A horizon likely removed or buried. The soil organic matter, pH and chemistry in the A horizon is likely not suitable for the proposed plants and should be modified as required.
 2. Soil Fracturing:
 - a. Step one: After grading and removing all plants and debris from the surface, spread 2 – 3 inches of Compost over the surface of the soil. Loosen the soil to depth of 18 - 24 inches, using a backhoe to dig into the soil through the Compost. Lift and then drop the loosened soil immediately back into the hole. The bucket then moves to the adjacent soil and repeats the process until the entire area indicated has been loosened.
 - b. Step 2: Spread 3-4 inches of Compost over the ripped area and till into the top 6 inches of the soil surface.
 3. Trenching:
 - a. Step one: After grading and removing all plants and debris from the surface using a chain trenching machine, dig 24 inch deep trenches, 24 inches apart across the entire area. Maintain an 18-inch standoff from the edges of all curbs, paving and structures. Backfill the trenches with Compost.
 - b. Step 2: Spread 3-4 inches of Compost over the trenches area and till into the top 6 inches of the soil surface. Compost tilling treatment shall extend to the edges of curbs, paving and structures.

4. Following soil ripping or fracturing the average penetration resistance should be less than 250 psi to the depth of the ripping or fracturing.
 5. Do not start planting into ripped or fractured soil until soil has been settled or leave grades sufficiently high to anticipate settlement of 10 – 15% of ripped soil depth.
- F. Modified existing soil – low organic matter
1. Description of condition to be modified: Low soil organic matter and/or missing A horizon but soil is not compacted except for some minor surface compaction. The soil organic matter, pH and/or chemistry are likely not suitable for the proposed plants and should be modified as required.
 2. Modifications:
 - a. Spread 3 - 4 inches of Compost over the surface of the soil and make chemical adjustment as recommended by the soil test.
 - b. Till Compost into the top 6 inches of the soil.
- G. Modified existing soil – soil within the root zone of existing established trees
1. Description of condition to be modified: Surface compaction near or above root limited levels in the upper soil horizon the result of traffic or other mechanical compaction.
 2. Modifications:
 - a. Remove the tops of all plants to be removed from the root zone. Remove sod with a walk behind sod cutter. Do not grub out the roots of plants to be removed.
 - b. Use a pneumatic air knife to loosen the top 9 – 12 inches of the soil. Surface roots may move and separate from soil during this process but the bark on roots should not be broken
 - 1.) Pneumatic air knife shall be as manufactured by:
Concept Engineering Group, Inc., Verona, PA (412) 826-8800
or
Supersonic Air Knife, Inc., Allison Park, PA (866) 328 5723
 - c. Make chemical adjustment as recommended by the soil test and add 2 - 3 inches of Compost over the soil.
 - d. Using the pneumatic air knife, mix the Compost into the top 6 – 8 inches of the loosened soil.
 - e. Work in sections such that the entire process - including irrigation - can be completed in one day. Apply approximately one inch of water over the loosened soil at the completion of each day's work. Apply mulch or turf as indicated on the drawings within one week of the completion of work.

2.7 PLANTING SOIL MIXES

- A. General definition: Mixes of Existing Soil or Imported Topsoil, Coarse Sand, and or Compost to make a new soil that meets the project goals for the indicated planting area. These may be mixed off site or onsite, and will vary in Mix components and proportions as indicated.
- B. Planting Mix - moderately slow draining soil for trees, shrub beds and lawn bed areas.
1. A Mix of Imported Topsoil, Coarse Sand and Compost. The approximate Mix ratio shall be:

Mix component	% by moist volume
Imported Topsoil unscreened	45-50%
Coarse sand	40-45%

Compost 10%

2. Final tested organic matter between 2.75 and 4% (by dry weight).
3. Mix the Coarse Sand and Compost together first and then add to the Topsoil. Mix with a loader bucket to loosely incorporate the Topsoil into the Coarse Sand/Compost Mix. DO NOT OVER MIX! Do not mix with a soil blending machine. Do not screen the soil. Clumps of Soil, Compost and Coarse Sand will be permitted in the overall Mix.
4. At the time of final grading, add fertilizer if required to the Planting Soil at rates recommended by the testing results for the plants to be grown.
5. Provide a two gallon sample with testing data that includes recommendations for chemical additives for the types of plants to be grown. Samples and testing data shall be submitted at the same time.

2.8 PRE-EMERGENT HERBICIDES

- A. Chemical herbicides are designed to prevent seeds of selective plants from germinating. Exact type of herbicide shall be based on the specific plants to be controlled and the most effective date of application.
- B. Submit report of expected weed problems and the recommendation of the most effective control for approval by Owner's Representative. Provide manufacturer's literature and material certification that the product meets the requirements.

2.9 HEAVY DUTY PIPE DRAIN PIPE

- A. Drain pipe shall be 4 inch diameter, perforated, PVC, Schedule 40 pipe shall be used where it is deemed that drainage of soil areas is required. Holes in the pipe shall only be on the bottom quadrant. All fittings, elbows, unions, T's and screw caps shall be the same material and from the same manufacturer as the pipe. "T" and elbow joints shall be sanitary type connections. All joints shall be solvent welded. Submit manufacturer's product literature for approval by the Owner's Representative.
 1. When pipe has perforations on all quadrants, drape a 12 inch wide 4 mil plastic sheet over the length of the pipe to force water to the bottom of the pipe.
- B. Clean out: Clean out risers shall be 4 inch diameter Schedule 40 PVC solid pipe compatible with the bottom fitting and clean out screw cap. Elbow fitting at the bottom of the clean out riser. When the cleanout is in the middle of a pipe run the fitting shall be a sanitary T fitting. Screw cap FITTING shall be PVC Schedule 40.

2.10 MEDIUM DUTY PIPE DRAIN PIPE

- A. Drain pipe shall be 4 inch diameter, perforated, PVC, double wall (smooth interior wall / corrugated exterior wall) pipe shall be used where it is deemed that drainage of soil areas is required. Holes in the pipe shall only be on the bottom quadrant. All fittings, elbows, unions, T's and screw caps shall be the same material and from the same manufacturer as the pipe. "T" and elbow joints shall be sanitary type connections. All joints shall be gasketed bell and spigot. Example source A -2000 by Contech Construction Products or approved equal. Submit manufacturer's product literature for approval by the Owner's Representative.
 1. When pipe has perforations on all quadrants, drape a 12 inch wide 4 mil plastic sheet over the length of the pipe to force water to the bottom of the pipe.

- B. Clean out: Clean out risers shall be 4 inch diameter Schedule 40 PVC solid pipe compatible with the bottom fitting and clean out screw cap. Elbow fitting at the bottom of the clean out riser. When the cleanout is in the middle of a pipe run the fitting shall be a sanitary T fitting. Screw cap FITTING shall be PVC Schedule 40.

2.11 LIGHT DUTY PIPE DRAIN PIPE

- A. Drain pipe shall be 4 inch diameter, perforated, HDPE, single wall corrugated exterior pipe. ASTM F405. All fittings, elbows, unions, T's and screw caps shall be the same material and from the same manufacturer as the pipe shall be used where it is deemed that drainage of soil areas is required. All joints shall be gasketed bell and spigot. Example source ADS Single Wall Pipe by Advance Drainage Systems or approved equal. Submit manufacturer's product literature for approval by the Owner's Representative.
 - 1. When pipe has perforations on all quadrants, drape a 12 inch wide 4 mil plastic sheet over the length of the pipe to force water to the bottom of the pipe.
- B. Clean out: Clean out risers shall be 4 inch diameter Schedule 40 PVC solid pipe compatible with the bottom fitting and clean out screw cap. Elbow fitting at the bottom of the clean out riser. When the cleanout is in the middle of a pipe run the fitting shall be a sanitary T fitting. Screw cap FITTING shall be PVC Schedule 40.

PART 3 – EXECUTION

3.1 SITE EXAMINATION

- A. Prior to installation of Planting Soil, examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.
 - 1. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.
 - 2. Confirm that surface all areas to be filled with Planting Soil are free of construction debris, refuse, compressible or biodegradable materials, stones greater than 2 inches diameter, soil crusting films of silt or clay that reduces or stops drainage from the Planting Soil into the subsoil; and/or standing water. Remove unsuitable material from the site.
 - 3. Confirm that no adverse drainage conditions are present.
 - 4. Confirm that no conditions are present which are detrimental to plant growth.
 - 5. Confirm that utility work has been completed per the drawings.
 - 6. Confirm that irrigation work, which is shown to be installed below prepared soil levels, has been completed.
- B. If unsatisfactory conditions are encountered, notify the Owner's Representative immediately to determine corrective action before proceeding.

3.2 COORDINATION WITH PROJECT WORK

- A. The Contractor shall coordinate with all other work that may impact the completion of the work.
- B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

- C. Coordinate the relocation of any irrigation lines, heads or the conduits of other utility lines that are in conflict with tree locations. Root balls shall not be altered to fit around lines. Notify the Owner's Representative of any conflicts encountered.

3.3 GRADE AND ELEVATION CONTROL

- A. Provide grade and elevation control during installation of Planting Soil. Utilize grade stakes, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.

3.4 SITE PREPARATION

- A. Excavate to the proposed subgrade. Maintain all required angles of repose of the adjacent materials as shown on the drawings or as required by this specification. Do not over excavate compacted subgrades of adjacent pavement or structures. Maintain a supporting 1:1 side slope of compacted subgrade material along the edges of all paving and structures where the bottom of the paving or structure is above the bottom elevation of the excavated planting area.
- B. Remove all construction debris and material including any construction materials from the subgrade.
- C. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope approximately parallel to the finished grade and/or toward the subsurface drain lines as shown on the drawings.
- D. In areas where Planting Soil is to be spread, confirm subgrade has been scarified.
- E. Protect adjacent walls, walks and utilities from damage or staining by the soil. Use 1/2 inch plywood and or plastic sheeting as directed to cover existing concrete, metal and masonry work and other items as directed during the progress of the work.
 - 1. At the end of each working day, clean up any soil or dirt spilled on any paved surface.
 - 2. Any damage to the paving or site features or work shall be repaired at the Contractor's expense.

3.5 SOIL MOISTURE

- A. Volumetric soil moisture level, in both the Planting Soil and the root balls of all plants, prior to, during and after planting shall be above permanent wilt point and below field capacity for each type of soil texture within the following ranges.

Soil texture	Permanent wilting point	Field capacity
Sand, Loamy sand, Sandy loam	5-8%	12-18%
Loam, Sandy clay, Sandy clay loam	14-25%	27-36%
Clay loam, Silt loam	11-22%	31-36%
Silty clay, Silty clay loam	22-27%	38-41%

- B. The Contractor shall confirm the soil moisture levels with a moisture meter (Digital Soil

Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equivalent). If moisture is found to be too low, the planting holes shall be filled with water and allowed to drain before starting any planting operations. If the moisture is too high, suspend planting operations until the soil moisture drains to below field capacity.

3.6 EXISTING SOIL MODIFICATION

- A. Follow the requirements for modifying existing soil as indicated in Part 2 for the different types of soil modifications. The extent of the areas of different soil modification types are indicated on the Soils Plan or as directed by the Owner's Representative.

3.7 DRAIN PIPE INSTALLATION

1. Trench lines to depths and widths shown on plans.
2. Place 2 – 3 inches Coarse Sand as bedding for pipes.
3. Place pipe (holes facing down) to invert elevations shown on the plan.
 - a. If pipe with holes on all sides is used drape a piece of 4 mil plastic 12 inches wide over top of pipe.
 - b. Cover sides and top of pipe with Coarse Sand with min 4 inches of Coarse Sand cover above top of pipe.
 - c. Backfill trench with Planting Soil compacted to same level as Planting Soil requirements.
4. Add cleanout pipe reaching the surface at the uphill end of each pipe run as shown on drawings.
5. Connect pipes to manhole or daylight outfall as shown on the drawings.

3.8 PLANTING SOIL AND PLANTING SOIL MIX INSTALLATION

- A. Prior to installing any Planting Soil from stockpiles or Planting Soil Mixes blended off site, the Owner's Representative shall approve the condition of the subgrade and the previously installed subgrade preparation and the installation of subsurface drainage.
- B. All equipment utilized to install or grade Planting Soils shall be wide track or balloon tire machines rated with a ground pressure of 4 psi or less. All grading and soil delivery equipment shall have buckets equipped with 6 inch long teeth to scarify any soil that becomes compacted.
- C. In areas of soil installation above existing subsoil, scarify the subgrade material prior to installing Planting Soil.
 1. Scarify the subsoil of the subgrade to a depth of 3 – 6 inches with the teeth of the back hoe or loader bucket, tiller or other suitable device.
 2. Immediately install the Planting Soil. Protect the loosened area from traffic. DO NOT allow the loosened subgrade to become compacted.
 3. In the event that the loosened area becomes overly compacted, loosen the area again prior to installing the Planting Soil.
- D. Install the Planting Soil in 12 - 18 inch lifts to the required depths (or noted depth for lawn bed areas). Apply compacting forces to each lift as required to attain the required compaction. Scarify the top of each lift prior to adding more Planting Soil by dragging the teeth of a loader bucket or backhoe across the soil surface to roughen the surface.

- E. Phase work such that equipment to deliver or grade soil does not have to operate over previously installed Planting Soil. Work in rows of lifts the width of the extension of the bucket on the loader. Install all lifts in one row before proceeding to the next. Work out from the furthest part of each bed from the soil delivery point to the edge of the each bed area.
- F. Where possible place large trees first and fill Planting Soil around the root ball.
- G. Installing soil with soil or mulch blowers or soil slingers shall not be permitted due to the over mixing and soil ped breakdown cause by this type of equipment.
- H. Where travel over installed soil is unavoidable, limit paths of traffic to reduce the impact of compaction in Planting Soil. Each time equipment passes over the installed soil it shall reverse out of the area along the same path with the teeth of the bucket dropped to scarify the soil. Comply with the paragraph "Compaction Reduction" (section 3.9) in the event that soil becomes over compacted.
- I. The depths and grades shown on the drawings are the final grades after settlement and shrinkage of the compost material. The Contractor shall install the Planting Soil at a higher level to anticipate this reduction of Planting Soil volume. A minimum settlement of approximately 10 - 15% of the soil depth is expected. All grade increases are assumed to be as measured prior to addition of surface Compost till layer, mulch, or sod.

1. Planting Soil Depths for the Project *

a. Lawn (Seeded)	6" Depth
b. Lawn (Sod)	5" Depth
c. Planting Beds	18" Depth

*Note: See Civil Engineering Drawings and Specifications for all other components of the retention basin requirements.

3.9 COMPACTION REQUIREMENTS FOR INSTALLED OR MODIFIED PLANTING SOIL

- A. Compact installed Planting Soil to the compaction rates indicated and using the methods approved for the soil mockup. Compact each soil lift as the soil is installed.
- B. Existing soil that is modified by tilling, ripping or fracturing shall have a density to the depth of the modification, after completion of the loosening, such that the penetrometer reads approximately 75 to 250 psi at soil moisture approximately the mid-point between wilting point and field capacity. This will be approximately between 75 and 82% of maximum dry density standard proctor.
- C. Installed Planting Soil Mix and re-spread existing soil shall have a soil density through the required depth of the installed layers of soil, such that the penetrometer reads approximately 75 to 250 psi at soil moisture approximately the mid-point between wilt point and field capacity. This will be approximately between 75 and 82% of maximum dry density standard proctor.
- D. Planting Soil compaction shall be tested at each lift using a penetrometer calibrated to the mockup soil and its moisture level. The same penetrometer and moisture meter used for the testing of the mockup shall be used to test installed soil throughout the work.
- E. Maintain moisture conditions within the Planting Soil during installation or modification to allow for satisfactory compaction. Suspend operations if the Planting Soil becomes wet. Apply water if the soil is overly dry.
- F. Provide adequate equipment to achieve consistent and uniform compaction of the Planting Soils. Use the smallest equipment that can reasonably perform the task of spreading and

compaction. Use the same equipment and methods of compaction used to construct the Planting Soil mockup.

- G. Do not pass motorized equipment over previously installed and compacted soil except as authorized below.
 - 1. Light weight equipment such as trenching machines or motorized wheel barrows is permitted to pass over finished soil work.
 - 2. If work after the installation and compaction of soil compacts the soil to levels greater than the above requirements, follow the requirements of the paragraph "Over Compaction Reduction" below.

3.10 OVER COMPACTION REDUCTION

- A. Any soil that becomes compacted to a density greater than the specified density and/or the density in the approved mockup shall be dug up and reinstalled. This requirement includes compaction caused by other sub-contractors after the Planting Soil is installed and approved.
- B. Surface roto tilling shall not be considered adequate to reduce over compaction at levels 6 inches or greater below finished grade.

3.11 INSTALLATION OF CHEMICAL ADDITIVES

- A. Following the installation of each soil and prior to fine grading and installation of the Compost till layer, apply chemical additives as recommended by the soil test, and appropriate to the soil and specific plants to be installed.
- B. Types, application rates and methods of application shall be approved by the Owner's Representative prior to any applications.

3.12 FINE GRADING

- A. The Owner's Representative shall approve all rough grading prior to the installation of Compost, fine grading, planting, and mulching.
- B. Grade the finish surface of all planted areas to meet the grades shown on the drawings, allowing the finished grades to remain higher (10 – 15% of depth of soil modification) than the grades on the grading plan, as defined in paragraph Planting Soil Installation, to anticipate settlement over the first year.
- C. Utilize hand equipment, small garden tractors with rakes, or small garden tractors with buckets with teeth for fine grading to keep surface rough without further compaction. Do not use the flat bottom of a loader bucket to fine grade, as it will cause the finished grade to become overly smooth and or slightly compressed.
- D. Provide for positive drainage from all areas toward the existing inlets, drainage structures and or the edges of planting beds. Adjust grades as directed to reflect actual constructed field conditions of paving, wall and inlet elevations. Notify the Owner's Representative in the event that conditions make it impossible to achieve positive drainage.
- E. Provide smooth, rounded transitions between slopes of different gradients and direction. Modify the grade so that the finish grade before adding mulch and after settlement is one or two inches below all paving surfaces or as directed by the drawings.
- F. Fill all dips and remove any bumps in the overall plane of the slope. The tolerance for dips and bumps in shrub and ground cover planting areas shall be a 2 inch deviation from the

plane in 10 feet. The tolerance for dips and bumps in lawn areas shall be a 1 inch deviation from the plane in 10 feet.

3.13 INSTALLATION OF COMPOST TILL LAYER

- A. After Planting Soil Mixes are installed in planting bed areas and just prior to the installation of shrub or groundcover plantings, spread 3 – 4 inches of Compost over the beds and roto till into the top 4 - 6 inches of the Planting Soil. This step will raise grades slightly above the grades required in paragraph "Fine Grading". This specification anticipates that the raise in grade due to this tilling will settle within a few months after installation as Compost breaks down. Additional settlement as defined in paragraph "Planting Soil and Planting Soil Mix installation" must still be accounted for in the setting of final grades.

3.14 CLEAN-UP

- A. During installation, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.
 - 1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.
- B. Once installation is complete, wash all soil from pavements and other structures. Ensure that mulch is confined to planting beds and that all tags and flagging tape are removed from the site. The Owner's Representative seals are to remain on the trees and removed at the end of the warranty period.
 - 1. Make all repairs to grades, ruts, and damage to the work or other work at the site.
 - 2. Remove and dispose of all excess Planting Soil, subsoil, mulch, plants, packaging, and other material brought to the site by the Contractor.

3.15 PLANTING SOIL AND MODIFIED EXISTING SOIL PROTECTION

- A. The Contractor shall protect installed and/or modified Planting Soil from damage including contamination and over compaction due to other soil installation, planting operations, and operations by other Contractors or trespassers. Maintain protection during installation until acceptance. Utilize fencing and matting as required or directed to protect the finished soil work. Treat, repair or replace damaged Planting Soil immediately.
- B. Loosen compacted Planting Soil and replace Planting Soil that has become contaminated as determined by the Owner's Representative. Planting Soil shall be loosened or replaced at no expense to the Owner.
 - a. Till and restore grades to all soil that has been driven over or compacted during the installation of plants.
 - b. Where modified existing soil has become contaminated and needs to be replaced, provide imported soil that is of similar composition, depth and density as the soil that was removed.

3.16 PROTECTION DURING CONSTRUCTION

- A. The Contractor shall protect planting and related work and other site work from damage due to planting operations, operations by other Contractors or trespassers.

1. Maintain protection during installation until the date of plant acceptance (see specifications section – Planting). Treat, repair or replace damaged work immediately.
 2. Provide temporary erosion control as needed to stop soil erosion until the site is stabilized with mulch, plantings or turf.
- B. Damage done by the Contractor, or any of their sub-contractors to existing or installed plants, or any other parts of the work or existing features to remain, including large existing trees, soil, paving, utilities, lighting, irrigation, other finished work and surfaces including those on adjacent property, shall be cleaned, repaired or replaced by the Contractor at no expense to the Owner. The Owner's Representative shall determine when such cleaning, replacement or repair is satisfactory. Damage to existing trees shall be assessed by a certified arborist.

3.17 SUBSTANTIAL COMPLETION ACCEPTANCE

- A. Upon written notice from the Contractor, the Owners Representative shall review the work and make a determination if the work is substantially complete.
- B. The date of substantial completion of the planting soil shall be the date when the Owner's Representative accepts that all work in Planting, Planting Soil, and Irrigation installation sections is complete.

3.18 FINAL ACCEPTANCE / SOIL SETTLEMENT

- A. At the end of the plant warrantee and maintenance period, (see Specification section - Planting) the Owner's Representative shall observe the soil installation work and establish that all provisions of the contract are complete and the work is satisfactory.
 1. Restore any soil settlement and or erosion areas to the grades shown on the drawings. When restoring soil grades remove plants and mulch and add soil before restoring the planting. Do not add soil over the root balls of plants or on top of mulch.
- B. Failure to pass acceptance: If the work fails to pass final acceptance, any subsequent observations must be rescheduled as per above. The cost to the Owner for additional observations will be charged to the Contractor at the prevailing hourly rate of the Owner's Representative.

END OF SECTION 329100

SECTION 32 9200
TURFS AND GRASSES

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:

1. Seeding.
2. Sodding.

- B. Related Sections include the following:

1. Division 31 Section 1000 for "Site Clearing" for topsoil stripping and stockpiling.
2. Division 31 Section 2000 for "Earthwork" for excavation, filling and backfilling, and rough grading.
3. Division 33 Section 4100 for "Storm Utility Drainage Pipig" for subsurface drainage.
4. Division 32 Section 9100 for "Planting Soil" for planting mix, on-site topsoil, imported topsoil and amendments to on-site soils.

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.
- D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.

- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and 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.
 - 1. Certification of each seed mixture for turfgrass sod, identifying source, including name and telephone number of supplier.
- C. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.
- D. Qualification Data: For landscape Installer.
- E. Material Test Reports: For existing surface soil and imported topsoil.
- F. Planting Schedule: Indicating anticipated planting dates for each type of planting.
- G. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
 - 1. A&L Eastern Agricultural Laboratories, Inc. 7621 Whitepine Rd., Richmond, VA 23237. <http://aleastern.com>.
 - 2. Agri Analysis, Inc. PO Box 483, 280 Newport Rd. Leola, PA 17540. <http://agrianalysis.com>.
 - 3. AgroLab, Inc. 1009 Matttlind Way, Milford, DE 19963. <http://agrolab.us>.
- C. Soil Analysis: For both on-site topsoil harvested and off-site acquired topsoil furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
 - 1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.
 - 2. Analysis reports are required from at least four (4) separate test locations for on-site topsoil material intended to be reused on the project.

3. Topsoil analysis reports for off-site manufactured topsoil material is to have been performed within the previous six month period prior to delivery.
 4. Topsoil sampling shall be done by the Contractor: within 6 months of installation, at installation, 6 months after installation and just prior to the completion of the warranty period for all plantings, to ensure soil make-up and fertilization requirements are being met.
 5. Random topsoil tests from the installed material may be taken by the Landscape Architect or Owner to ensure that the topsoil material meets the Specification and placed to the required depth. Topsoil that does not meet the Specification is to be removed from the site by the Contractor (at the Contractors expense) to the depth described and replaced (at the Contractors expense) with topsoil that does meet the Specification based on new submitted topsoil analysis reports of the topsoil material.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding."

1.7 SCHEDULING

- A. 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. Spring Planting: March 15 – June 15.
 2. Fall Planting: Oct. 15 – Nov. 15.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.8 LAWN MAINTENANCE

- A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:
 1. Seeded Lawns: 60 days from date of Substantial Completion.
 - a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.
 2. Sodded Lawns: 60 days from date of Substantial Completion.

- B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
 - 1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.
- C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn 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 lawn at a minimum rate of 1 inch per week.
- D. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent 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 grass 1 to 2 inches high.
- E. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
 - 1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to lawn area.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species: State-certified seed of grass species, as follows:
- C. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 - 1. Sun and Partial Shade: Proportioned by weight as follows:
 - 1) Seed Mix: 80% Three-Way Tall Turf Type Fescue (two or more of the following varieties; Cochise IV, 3rd Millennium, Falcon V or Firecracker LS), 10% Kentucky Bluegrass (one or more of the following varieties; Midnight, Bewitched, Bedazzled, or Award), and 10% Perennial Ryegrass (one or more of the following varieties; Amazing, Fiesta 4, or Manhattan 5).
 - 2. Shade: Proportioned by weight as follows:
 - 1) Seed Mix: 70% Three-Way Tall Turf Type Fescue (two or more of the following varieties; Cochise IV, 3rd Millennium, Falcon V or Firecracker LS),

20% Chewings red fescus (*Festuca rubra* variety), and 10% Redtop (*Agrostis alba*).

2.2 TURFGRASS SOD

- A. Turfgrass Sod: Certified, complying with TPI's "Specifications for Turfgrass Sod Materials" in its "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 - a. Lawn Sod (if applicable): Maryland Certified Sod from a local grower.

2.3 TOPSOILS AND PLANTING SOIL MIXES

- 1. See Division 32 Section "Planting Soils" for all items related to planting soils for seeded and sodded turf areas.

2.4 PLANTING ACCESSORIES

- A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.5 FERTILIZER

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 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: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-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: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.6 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

- B. Peat Mulch: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.
- C. Peat Mulch: Finely divided or granular texture, with a pH range of 6 to 7.5, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water-absorbing capacity of 1100 to 2000 percent.
- 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 (25-mm) sieve; soluble salt content of 5 to 10 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.

2.7 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.
- B. Erosion-Control Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

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 seeding overspray.
- B. Provide 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 LAWN PREPARATION

- A. Limit lawn subgrade preparation to areas to be planted.

- B. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- C. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.4 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
- B. Sow seed at the rate of noted above per seed species.
- C. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:6 with erosion-control fiber mesh and 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.
- E. 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 depth over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Anchor straw mulch by crimping into topsoil with suitable mechanical equipment.
- F. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak and scatter uniformly to a depth of 3/16 inch and roll to a smooth surface.

3.5 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
 - 1. Lay sod across angle of slopes exceeding 1:3.
 - 2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
- C. Saturate sod with fine water spray within two hours of planting. During first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.6 SATISFACTORY LAWNS

- A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 95 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
- B. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.
- C. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.7 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.
- C. Remove erosion-control measures after grass establishment period.

END OF SECTION 329200

SECTION 32 9300
PLANTING

PART 1 – GENERAL

1.1 SUMMARY

- A. The scope of work includes all labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation of plant (also known as "landscaping") complete as shown on the drawings and as specified herein.
- B. The scope of work in this section includes, but is not limited to, the following:
 - 1. Locate, purchase, deliver and install all specified plants.
 - 2. Water all specified plants.
 - 3. Mulch, fertilize, stake, and prune all specified plants.
 - 4. Maintenance of all specified plants until the beginning of the warranty period.
 - 5. Plant warranty.
 - 6. Clean up and disposal of all excess and surplus material.
 - 7. Maintenance of all specified plants during the warranty period.

1.2 CONTRACT DOCUMENTS

- A. Shall consist of specifications and general conditions and the construction drawings. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any parts shall be as binding as if called for in all parts.

1.3 RELATED DOCUMENTS AND REFERENCES

- A. Related Documents:
 - 1. Drawings and general provisions of contract including general and supplementary conditions and Division I specifications apply to work of this section.
 - 2. Related Specification Sections
 - a. Section 32 Section 9100 for "Planting Soil".
 - b. Section 32 Section 9200 for "Turfs and Grasses".
 - c. Section 32 Section 9210 for "Meadow Seeding".
 - d. Section 02 Section 2310 for "Tree Protection".
- B. References: The following specifications and standards of the organizations and documents listed in this paragraph form a part of the specification to the extent required by the references thereto. In the event that the requirements of the following referenced standards and specification conflict with this specification section the requirements of this specification shall prevail. In the event that the requirements of any of the following referenced standards and specifications conflict with each other the more stringent requirement shall prevail or as determined by the Owners Representative.

1. ANSI Z60.1 American Standard for Nursery Stock, most current edition.
2. ANSI A 300 – Standard Practices for Tree, Shrub and other Woody Plant Maintenance, most current edition and parts.
3. Interpretation of plant names and descriptions shall reference the following documents. Where the names or plant descriptions disagree between the several documents, the most current document shall prevail.
 - a. USDA - The Germplasm Resources Information Network ([GRIN](http://www.ars-grin.gov/npgs/searchgrin.html)) <http://www.ars-grin.gov/npgs/searchgrin.html>
 - b. Manual of Woody Landscape Plants; Michael Dirr; Stipes Publishing, Champaign, Illinois; Most Current Edition.
 - c. The New Sunset Western Garden Book, Oxmoor House, most current edition.
4. Pruning practices shall conform to recommendations “Structural Pruning: A Guide For The Green Industry” most current edition; published by Urban Tree Foundation, Visalia, California.
5. Glossary of Arboricultural Terms, International Society of Arboriculture, Champaign IL, most current edition.

1.4 VERIFICATION

- A. All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions and quantities, and shall immediately inform the Owner’s Representative of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given approval to do so by the Owner’s Representative.
- B. In the case of a discrepancy in the plant quantities between the plan drawings and the plant call outs, list or plant schedule, the number of plants or square footage of the planting bed actually drawn on the plan drawings shall be deemed correct and prevail.

1.5 PERMITS AND REGULATIONS

- A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owner’s Representative in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.
- B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.
- C. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or Owner’s Representative shall determine which shall govern.

1.6 PROTECTION OF WORK, PROPERTY AND PERSON

- A. The Contractor shall adequately protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to his/her actions.

1.7 CHANGES IN THE WORK

- A. The Owner's Representative may order changes in the work, and the contract sum should be adjusted accordingly. All such orders and adjustments plus claims by the Contractor for extra compensation must be made and approved in writing before executing the work involved.
- B. All changes in the work, notifications and contractor's request for information (RFI) shall conform to the contract general condition requirements.

1.8 CORRECTION OF WORK

- A. The Contractor, at their own cost, shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Owner's Representative, at the soonest as possible time that can be coordinated with other work and seasonal weather demands.

1.9 DEFINITIONS

All terms in this specification shall be as defined in the "Glossary of Arboricultural Terms" or as modified below.

- A. Boxed trees: A container root ball package made of wood in the shape of a four-sided box.
- B. Container plant: Plants that are grown in and/or are currently in a container including boxed trees.
- C. Defective plant: Any plant that fails to meet the plant quality requirement of this specification.
- D. End of Warranty Final Acceptance: The date when the Owner's Representative accepts that the plants and work in this section meet all the requirements of the warranty. It is intended that the materials and workmanship warranty for Planting, Planting Soil, and Irrigation work run concurrent with each other.
- E. Field grown trees (B&B): Trees growing in field soil for at least 12 months prior to harvest.
- F. Healthy: Plants that are growing in a condition that expresses leaf size, crown density, color; and with annual growth rates typical of the species and cultivar's horticultural description, adjusted for the planting site soil, drainage and weather conditions.
- G. Kinked root: A root within the root package that bends more than 90 degrees.
- H. Maintenance: Actions that preserve the health of plants after installation and as defined in this specification.
- I. Maintenance period: The time period, as defined in this specification, which the Contractor is to provide maintenance.
- J. Normal: the prevailing protocol of industry standard(s).
- K. Owner's Representative: The person appointed by the Owner to represent their interest in the review and approval of the work and to serve as the contracting authority with the Contractor. The Owner's Representative may appoint other persons to review and approve any aspects of the work.
- L. Reasonable and reasonably: When used in this specification relative to plant quality, it is intended to mean that the conditions cited will not affect the establishment or long term stability, health or growth of the plant. This specification recognizes that it is not possible to produce plants free of all defects, but that some accepted industry protocols and standards result in plants unacceptable to this project.

When reasonable or reasonably is used in relation to other issues such as weeds, diseased, insects, it shall mean at levels low enough that no treatment would be required when applying recognized Integrated Plant Management practices.

This specification recognizes that some decisions cannot be totally based on measured findings and that professional judgment is required. In cases of differing opinion, the Owner's Representative's expert shall determine when conditions are judged as reasonable.

- M. Root ball: The mass of roots including any soil or substrate that is shipped with the tree within the root ball package.
- N. Root ball package. The material that surrounds the root ball during shipping. The root package may include the material in which the plant was grown, or new packaging placed around the root ball for shipping.
- O. Root collar (root crown, root flare, trunk flare, flare): The region at the base of the trunk where the majority of the structural roots join the plant stem, usually at or near ground level.
- P. Shrub: Woody plants with mature height approximately less than 15 feet.
- Q. Spade harvested and transplanted: Field grown trees that are mechanically harvested and immediately transplanted to the final growing site without being removed from the digging machine.
- R. Stem: The trunk of the tree.
- S. Substantial Completion Acceptance: The date at the end of the Planting, Planting Soil, and Irrigation installation where the Owner's Representative accepts that all work in these sections is complete and the Warranty period has begun. This date may be different than the date of substantial completion for the other sections of the project.
- T. Stem girdling root: Any root more than ¼ inch diameter currently touching the trunk, or with the potential to touch the trunk, above the root collar approximately tangent to the trunk circumference or circling the trunk. Roots shall be considered as Stem Girdling that have, or are likely to have in the future, root to trunk bark contact.
- U. Structural root: One of the largest roots emerging from the root collar.
- V. Tree: Single and multi-stemmed plants with mature height approximately greater than 15 feet.

1.10 SUBMITTALS

- A. See contract general conditions for policy and procedure related to submittals.
- B. Submit all product submittals at least 8 weeks prior to installation of plantings.
- C. Product data: Submit manufacturer product data and literature describing all products required by this section to the Owner's Representative for approval. Provide submittal eight weeks before the installation of plants.
- D. Plant growers' certificates: Submit plant growers' certificates for all plants indicating that each meets the requirements of the specification, including the requirements of tree quality, to the Owner's Representative for approval. Provide submittal eight weeks before the installation of plants.
- E. Samples: Submit samples of each product and material where required by the specification to the Owner's Representative for approval. Label samples to indicate product, characteristics, and locations in the work. Samples will be reviewed for appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

- F. Plant sources: Submit sources of all plants as required by Article – “Selection of Plants” to the Owner’s Representative for approval.
- G. Close out submittals: Submit to the Owner’s Representative for approval.
 - 1. Plant maintenance data and requirements.
- H. Warranty period site visit record: If there is no maintenance during the warranty period, after each site visit during the warranty period, by the Contractor, as required by this specification, submit a written record of the visit, including any problems, potential problems, and any recommended corrective action to the Owner’s Representative for approval.
- I. Installation plan submitted a minimum of 14 days prior to the scheduled installation. Plan should describe the methods, activities, materials and schedule to achieve installation of plants.

1.11 OBSERVATION OF THE WORK

- A. The Owner’s Representative may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor’s expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Owner’s Representative shall be informed of the progress of the work so the work may be observed at the following key times in the construction process. The Owner’s Representative shall be afforded sufficient time to schedule visit to the site. Failure of the Owner’s Representative to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.
 - 1. SITE CONDITIONS PRIOR TO THE START OF PLANTING: review the soil and drainage conditions.
 - 2. COMPLETION OF THE PLANT LAYOUT STAKING: Review of the plant layout.
 - 3. PLANT QUALITY: Review of plant quality at the time of delivery and prior to installation. Review tree quality prior to unloading where possible, but in all cases prior to planting.
 - 4. COMPLETION OF THE PLANTING: Review the completed planting.

1.12 PRE-CONSTRUCTION CONFERENCE

- A. Schedule a pre-construction meeting with the Owner’s Representative at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction and project work schedule.

1.13 QUALITY ASSURANCE

- A. Substantial Completion Acceptance - Acceptance of the work prior to the start of the warranty period:
 - 1. Once the Contractor completes the installation of all items in this section, the Owner’s Representative will observe all work for Substantial Completion Acceptance upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date of the observation.
 - 2. Substantial Completion Acceptance by the Owner’s Representative shall be for general conformance to specified size, character and quality and not relieve the Contractor of responsibility for full conformance to the contract documents, including correct species.

3. Any plants that are deemed defective as defined under the provisions below shall not be accepted.
- B. The Owner's Representative will provide the Contractor with written acknowledgment of the date of Substantial Completion Acceptance and the beginning of the warranty period and plant maintenance period (if plant maintenance is included).
- C. Contractor's Quality Assurance Responsibilities: The Contractor is solely responsible for quality control of the work.
- D. Installer Qualifications: The installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the work, including the handling and planting of large specimen trees in urban areas. The same firm shall install planting soil (where applicable) and plant material.
 1. The bidders list for work under this section shall be approved by the Owner's Representative.
 2. Installer Field Supervision: When any planting work is in progress, installer shall maintain, on site, a full-time supervisor who can communicate in English with the Owner's Representative.
 3. Installer's field supervisor shall have a minimum of five years of experience as a field supervisor installing plants and trees of the quality and scale of the proposed project, and can communicate in English with the Owner's Representative.
 4. The installer's crew shall have a minimum of 3 years experienced in the installation of Planting Soil, Plantings, and Irrigation (where applicable) and interpretation of soil plans, planting plans and irrigation plans.
 5. Submit references of past projects, employee training certifications that support that the Contractors meets all of the above installer qualifications and applicable licensures.

1.14 PLANT WARRANTY

A. Plant Warranty:

1. The Contractor agrees to replace defective work and defective plants. The Owner's Representative shall make the final determination if plants meet these specifications or that plants are defective.

Plants warranty shall begin on the date of Substantial Completion Acceptance and continue for the following periods, classed by plant type:

- a. Trees – 1 Year(s).
 - b. Shrubs – 1 Year(s).
 - c. Ground cover and perennial flower plants – 1 Year(s).
 - d. Bulbs, annual flower and seasonal color plants – for the period of expected bloom or primary display.
2. When the work is accepted in parts, the warranty periods shall extend from each of the partial Substantial Completion Acceptances to the terminal date of the last warranty period. Thus, all warranty periods for each class of plant warranty, shall terminate at one time.
 3. All plants shall be warrantied to meet all the requirements for plant quality at installation in this specification. Defective plants shall be defined as plants not meeting these requirements. The Owner's representative shall make the final determination that plants are defective.

4. Plants determined to be defective shall be removed immediately upon notification by the Owner's Representative and replaced without cost to the Owner, as soon as weather conditions permit and within the specified planting period.
 5. Any work required by this specification or the Owner's Representative during the progress of the work, to correct plant defects including the removal of roots or branches, or planting plants that have been bare rooted during installation to observe for or correct root defects shall not be considered as grounds to void any conditions of the warranty. In the event that the Contractor decides that such remediation work may compromise the future health of the plant, the plant or plants in question shall be rejected and replaced with plants that do not contain defects that require remediation or correction.
 6. The Contractor is exempt from replacing plants, after Substantial Completion Acceptance and during the warranty period, that are removed by others, lost or damaged due to occupancy of project, lost or damaged by a third party, vandalism, or any natural disaster.
 7. Replacements shall closely match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this specification. Make all necessary repairs due to plant replacements. Such repairs shall be done at no extra cost to the Owner.
 8. The warranty of all replacement plants shall extend for an additional one-year period from the date of their acceptance after replacement. In the event that a replacement plant is not acceptable during or at the end of the said extended warranty period, the Owner's Representative may elect one more replacement items or credit for each item. These tertiary replacement items are not protected under a warranty period.
 9. During and by the end of the warranty period, remove all tree wrap, ties, and guying unless agreed to by the Owner's Representative to remain in place. All trees that do not have sufficient caliper to remain upright, or those requiring additional anchorage in windy locations, shall be staked or remain staked, if required by the Owner's Representative.
- B. End of Warranty Final Acceptance - Acceptance of plants at the end of the warranty period.
1. At the end of the warranty period, the Owner's Representative shall observe all warranted work, upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date for final observation.
 2. End of Warranty Final Acceptance will be given only when all the requirements of the work under this specification and in specification sections Planting Soil and Irrigation have been met.

1.15 SELECTION AND OBSERVATION OF PLANTS

- A. The Owner's Representative may review all plants subject to approval of size, health, quality, character, etc. Review or approval of any plant during the process of selection, delivery, installation and establishment period shall not prevent that plant from later rejection in the event that the plant quality changes or previously existing defects become apparent that were not observed.
- B. Plant Selection: The Owner's Representative reserves the right to select and observe all plants at the nursery prior to delivery and to reject plants that do not meet specifications as set forth in this specification. If a particular defect or substandard element can be corrected at the nursery, as determined by the Owner's Representative, the agreed upon remedy may be applied by the nursery or the Contractor provided that the correction allows the plant to meet the requirements set forth in this specification. Any work to correct plant defects shall be at

- the contractor's expense.
1. The Owner's Representative may make invasive observation of the plant's root system in the area of the root collar and the top of the root ball in general in order to determine that the plant meets the quality requirements for depth of the root collar and presence of roots above the root collar. Such observations will not harm the plant.
 2. Corrections are to be undertaken at the nursery prior to shipping.
- C. The Contractor shall bear all cost related to plant corrections.
- D. All plants that are rejected shall be immediately removed from the site and acceptable replacement plants provided at no cost to the Owner.
- E. Submit to the Owner's Representative, for approval, plant sources including the names and locations of nurseries proposed as sources of acceptable plants, and a list of the plants they will provide. The plant list shall include the botanical and common name and the size at the time of selection. Observe all nursery materials to determine that the materials meet the requirements of this section.
- F. Trees shall be purchased from the growing nursery. Re-wholesale plant suppliers shall not be used as sources unless the Contractor can certify that the required trees are not directly available from a growing nursery. When Re-wholesale suppliers are utilized, the Contractor shall submit the name and location of the growing nursery from where the trees were obtained by the re-wholesale seller. The re-wholesale nursery shall be responsible for any required plant quality certifications.
- G. The Contractor shall require the grower or re-wholesale supplier to permit the Owner's Representative to observe the root system of all plants at the nursery or job site prior to planting including random removal of soil or substrate around the base of the plant. Observation may be as frequent and as extensive as needed to verify that the plants meet the requirements of the specifications and conform to requirements.
- H. Each tree shall have a numbered seal applied by the Contractor. The seal shall be placed on a lateral branch on the north side of the tree. The seal shall be a tamper proof plastic seal bearing the Contractor's name and a unique seven-digit number embossed on the seal.
1. Do not place seals on branches that are so large that there is not sufficient room for the branch growth over the period of the warranty.
- I. The Owner's Representative may choose to attach their seal to each plant, or a representative sample. Viewing and/or sealing of plants by the Owner's Representative at the nursery does not preclude the Owner's Representative's right to reject material while on site. The Contractor is responsible for paying any up charge for the Owner's Representative to attach their seal to specific plants.
- J. Where requested by the Owner's Representative, submit photographs of plants or representative samples of plants. Photographs shall be legible and clearly depict the plant specimen. Each submitted image shall contain a height reference, such as a measuring stick. The approval of plants by the Owner's Representative via photograph does not preclude the Owner's Representative's right to reject material while on site.

1.16 PLANT SUBSTITUTIONS FOR PLANTS NOT AVAILABLE

- A. Submit all requests for substitutions of plant species, or size to the Owner's Representative, for approval, prior to purchasing the proposed substitution. Request for substitution shall be accompanied with a list of nurseries contacted in the search for the required plant and a record of other attempts to locate the required material. Requests shall also include sources of plants found that may be of a smaller or larger size, or a different shape or habit than

specified, or plants of the same genus and species but different cultivar origin, or which may otherwise not meet the requirements of the specifications, but which may be available for substitution.

1.17 SITE CONDITIONS

- A. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to notify the Owner's Representative, in writing, of any circumstances that would negatively impact the health of plantings. Do not proceed with work until unsatisfactory conditions have been corrected.
 - 1. Should subsurface drainage or soil conditions be encountered which would be detrimental to growth or survival of plant material, the Contractor shall notify the Owner's Representative in writing, stating the conditions and submit a proposal covering cost of corrections. If the Contractor fails to notify the Owner's Representative of such conditions, he/she shall remain responsible for plant material under the warranty clause of the specifications.
- B. It is the responsibility of the Contractor to be familiar with the local growing conditions, and if any specified plants will be in conflict with these conditions. Report any potential conflicts, in writing, to the Owner's Representative.
- C. This specification requires that all Planting Soil and Irrigation (if applicable) work be completed and accepted prior to the installation of any plants.
 - 1. Planting operations shall not begin until such time that the irrigation system is completely operational for the area(s) to be planted, and the irrigation system for that area has been preliminarily observed and approved by the Owner's Representative.
- D. Actual planting shall be performed during those periods when weather and soil conditions are suitable in accordance with locally accepted horticultural practices.
 - 1. Do not install plants into saturated or frozen soils. Do not install plants during inclement weather, such as rain or snow or during extremely hot, cold or windy conditions.

1.18 PLANTING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of *Local Utility Locator Service*, Palmetto Utility Protection Service, Inc. (888) 721-7877, is required for all planting areas: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the *Local Utility Locator Service*.

PART 2 – PRODUCTS

2.1 PLANTS: GENERAL

- A. Standards and measurement: Provide plants of quantity, size, genus, species, and variety or cultivars as shown and scheduled in contract documents.
 - 1. All plants including the root ball dimensions or container size to trunk caliper ratio shall

conform to ANSI Z60.1 "American Standard for Nursery Stock" latest edition, unless modified by provisions in this specification. When there is a conflict between this specification and ANSI Z60.1, this specification section shall be considered correct.

2. Plants larger than specified may be used if acceptable to the Owner's Representative. Use of such plants shall not increase the contract price. If larger plants are accepted the root ball size shall be in accordance with ANSI Z-60.1. Larger plants may not be acceptable if the resulting root ball cannot be fit into the required planting space.
 3. If a range of size is given, no plant shall be less than the minimum size and not less than 50 percent of the plants shall be as large as the maximum size specified. The measurements specified are the minimum and maximum size acceptable and are the measurements after pruning, where pruning is required.
- B. Proper Identification: All trees shall be true to name as ordered or shown on planting plans and shall be labeled individually or in groups by genus, species, variety and cultivar.
- C. Compliance: All trees shall comply with federal and state laws and regulations requiring observation for plant disease, pests, and weeds. Observation certificates required by law shall accompany each shipment of plants.
- D. Plant Quality:
1. General: Provide healthy stock, grown in a nursery and reasonably free of die-back, disease, insects, eggs, bores, and larvae. At the time of planting all plants shall have a root system, stem, and branch form that will not restrict normal growth, stability and health for the expected life of the plant.
 2. Plant quality above the soil line:
 - a. Plants shall be healthy with the color, shape, size and distribution of trunk, stems, branches, buds and leaves normal to the plant type specified. Tree quality above the soil line shall comply with the project Crown Acceptance details and the following:
 - 1.) Crown: The form and density of the crown shall be typical for a young specimen of the species or cultivar pruned to a central and dominant leader.
 - a.) Crown specifications do not apply to plants that have been specifically trained in the nursery as topiary, espalier, multi-stem, clump, or unique selections such as contorted or weeping cultivars.
 - 2.) Leaves: The size, color, and appearance of leaves shall be typical for the time of year and stage of growth of the species or cultivar. Trees shall not show signs of prolonged moisture stress or over watering as indicated by wilted, shriveled, or dead leaves.
 - 3.) Branches: Shoot growth (length and diameter) throughout the crown should be appropriate for the age and size of the species or cultivar. Trees shall not have dead, diseased, broken, distorted, or otherwise injured branches.
 - a.) Main branches shall be distributed along the central leader not clustered together. They shall form a balanced crown appropriate for the cultivar/species.
 - b.) Branch diameter shall be no larger than two-thirds (one-half is preferred) the diameter of the central leader measured 1 inch above the branch union.
 - c.) The attachment of the largest branches (scaffold branches) shall be free of included bark.
 - 4.) Trunk: The tree trunk shall be relatively straight, vertical, and free of wounds that penetrate to the wood (properly made pruning cuts, closed or not, are acceptable and are not considered wounds), sunburned areas, conks (fungal fruiting bodies),

- wood cracks, sap leakage, signs of boring insects, galls, cankers, girdling ties, or lesions (mechanical injury).
- 5.) Temporary branches, unless otherwise specified, can be present along the lower trunk below the lowest main (scaffold) branch, particularly for trees less than 1 inch in caliper. These branches should be no greater than 3/8-inch diameter. Clear trunk should be no more than 40% of the total height of the tree.
- b. Trees shall have one central leader. If the leader was headed, a new leader (with a live terminal bud) at least one-half the diameter of the pruning cut shall be present.
 - 1.) All trees are assumed to have one central leader trees unless a different form is specified in the plant list or drawings.
 - c. All graft unions, where applicable, shall be completely closed without visible sign of graft rejection. All grafts shall be visible above the soil line.
 - d. Trunk caliper and taper shall be sufficient so that the lower five feet of the trunk remains vertical without a stake. Auxiliary stake may be used to maintain a straight leader in the upper half of the tree.
3. Plant quality at or below the soil line:
 - a. Plant roots shall be normal to the plant type specified. Root observations shall take place without impacting tree health. Root quality at or below the soil line shall comply with the project Root Acceptance details and the following:
 - 1.) The roots shall be reasonably free of scrapes, broken or split wood.
 - 2.) The root system shall be reasonably free of injury from biotic (e.g., insects and pathogens) and abiotic (e.g., herbicide toxicity and salt injury) agents. Wounds resulting from root pruning used to produce a high quality root system are not considered injuries.
 - 3.) A minimum of three structural roots reasonably distributed around the trunk (not clustered on one side) shall be found in each plant. Root distribution shall be uniform throughout the root ball, and growth shall be appropriate for the species.
 - a.) Plants with structural roots on only one side of the trunk (J roots) shall be rejected.
 - 4.) The root collar shall be within the upper 2 inches of the substrate/soil. Two structural roots shall reach the side of the root ball near the top surface of the root ball. The grower may request a modification to this requirement for species with roots that rapidly descend, provided that the grower removes all stem girdling roots above the structural roots across the top of the root ball.
 - 5.) The root system shall be reasonably free of stem girdling roots over the root collar or kinked roots from nursery production practices.
 - a.) Plant Grower Certification: The final plant grower shall be responsible to have determined that the plants have been root pruned at each step in the plant production process to remove stem girdling roots and kinked roots, or that the previous production system used practices that produce a root system throughout the root ball that meets these specifications. Regardless of the work of previous growers, the plant's root system shall be modified at the final production stage, if needed, to produce the required plant root quality. The final grower shall certify in writing that all plants are reasonably free of stem girdling and kinked roots as defined in this specification, and that the tree has been grown and harvested to produce a plant that meets these specifications.
 - 6.) At time of observations and delivery, the root ball shall be moist throughout. Roots

shall not show signs of excess soil moisture conditions as indicated by stunted, discolored, distorted, or dead roots.

- E. Submittals: Submit for approval the required plant quality certifications from the grower where plants are to be purchased, for each plant type. The certification must state that each plant meets all the above plant quality requirements.
1. The grower's certification of plant quality does not prohibit the Owner's Representative from observing any plant or rejecting the plant if it is found to not meet the specification requirements.

2.2 ROOT BALL PACKAGE OPTIONS: The following root ball packages are permitted. Specific root ball packages shall be required where indicated on the plant list or in this specification. Any type of root ball packages that is not specifically defined in this specification shall not be permitted.

A. BALLED AND BURLAPPED PLANTS

1. All Balled and Burlapped Plants shall be field grown, and the root ball packaged in a burlap and twine and/or burlap and wire basket package.
2. Plants shall be harvested with the following modifications to standard nursery practices.
 - a. Prior to digging any tree that fails to meet the requirement for maximum soil and roots above the root collar, carefully removed the soil from the top of the root ball of each plant, using hand tools, water or an air spade, to locate the root collar and attain the soil depth over the structural roots requirements. Remove all stem girdling roots above the root collar. Care must be exercised not to damage the surface of the root collar and the top of the structural roots.
 - b. Trees shall be dug for a minimum of 4 weeks and a maximum of 52 weeks prior to shipping. Trees dug 4 to 52 weeks prior to shipping are defined as hardened-off. Digging is defined as cutting all roots and lifting the tree out of the ground and either moving it to a new location in the nursery or placing it back into the same hole. Trees that are stored out of the ground shall be placed in a holding area protected from extremes of wind and sun with the root ball protected by covering with mulch or straw and irrigated sufficiently to keep moisture in the root ball above wilt point and below saturation
 - c. If wire baskets are used to support the root ball, a "low profile" basket shall be used. A low profile basket is defined as having the top of the highest loops on the basket no less than 4 inches and no greater than 8 inches below the shoulder of the root ball package.
 - 1.) At nurseries where sandy soils prevent the use of "low profile baskets", baskets that support the entire root ball, including the top, are allowable.
 - d. Twine and burlap used for wrapping the root ball package shall be natural, biodegradable material. If the burlap decomposes after digging the tree then the root ball shall be re-wrapped prior to shipping if roots have not yet grown to keep root ball intact during shipping.

B. SPADE HARVESTED AND TRANSPLANTED

1. Spade Harvested and Transplanted Plants shall meet all the requirements for field grown trees. Root ball diameters shall be of similar size as the ANSI Z60.1 requirements for Balled and Burlapped plants.
2. Trees shall be harvested prior to leafing out (bud break) in the spring or during the fall

planting period except for plants know to be considered as fall planting hazards. Plants that are fall planting hazards shall only be harvested prior to leafing out in the spring.

3. Trees shall be moved and planted within 48 hours of the initial harvesting and shall remain in the spade machine until planted.

C. CONTAINER (INCLUDING ABOVE-GROUND FABRIC CONTAINERS AND BOXES) PLANTS

1. Container plants may be permitted only when indicated on the drawing, in this specification, or approved by the Owner's Representative.
2. Provide plants shall be established and well rooted in removable containers.
3. Container class size shall conform to ANSI Z60.1 for container plants for each size and type of plant.

D. BARE ROOT PLANTS

1. Harvest bare root plants while the plant is dormant and a minimum of 4 weeks prior to leaf out (bud break).
2. The root spread dimensions of the harvested plants shall conform to ANSI Z60.1 for nursery grown bare root plants for each size and type of plant. Just prior to shipping to the job site, dip the root system into a slurry of hydrogel (cross linked polyacrylamide) and water mixed at a rate of 15 oz. of hydrogel in 25 gallons of water. Do not shake off the excess hydrogel. Place the root system in a pleated black plastic bag and tie the bag snugly around the trunk. Bundle and tie the upper branches together.
3. Keep the trees in a cool dark space for storage and delivery. If daytime outside temperatures exceeds 70 degrees F, utilize a refrigerated storage area with temperature between 35 and 50 degrees.
4. Where possible, plan time of planting to be before bud break. For trees to be planted after bud break, place the trees before bud break in an irrigated bed of pea gravel.
 - a. The pea gravel bed shall be 18 inches deep over a sheet of plastic.
 - b. Space trees to allow the unbundled branches to grow without shading each other.
 - c. Once stored in pea gravel, allow the trees sufficient time for the new root system to flush and spring growth of leaves to fully develop before planting.
 - d. Pea gravel stored trees may be kept for up to one growing season.
 - e. Pea gravel stored trees shall be dipped, packaged and shipped similar to the requirements for freshly dug bare root trees above.

E. IN-GROUND FABRIC BAG-GROWN

1. In-ground fabric container plants may be permitted only when indicated on the drawing, in this specification, or approved by the Owner's Representative.
2. Provide plants established and well rooted.

2.3 ANNUAL FLOWERING AND SEASONAL COLOR PLANTS

- A. Container or flat-grown plants should be sized as noted in the planting plan. Plants shall be well-rooted and healthy.

2.4 PLANTING SOIL

- A. Planting Soil as used in this specification means the soil at the planting site, or imported as modified and defined in specification Section Planting Soil 32 9100. If there is no Planting Soil specification, the term Planting Soil shall mean the soil at the planting site within the planting hole.

2.5 MULCH

- A. Mulch shall be coarse, ground, from tree and woody brush sources. The size range shall be a minimum (less than 25% or less of volume) fine particles 3/8 inch or less in size, and a maximum size of individual pieces (largest 20% or less of volume) shall be approximately 1 to 1-1/2 inch in diameter and maximum length approximately 4 to 8". Pieces larger than 8 inch long that are visible on the surface of the mulch after installation shall be removed.
 - 1. It is understood that mulch quality will vary significantly from supplier to supplier and region to region. The above requirements may be modified to conform to the source material from locally reliable suppliers as approved by the Owner's Representative.
- B. Submit supplier's product specification data sheet and a one gallon sample for approval.

2.6 TREE STAKING AND GUYING MATERIAL

- A. Tree guying to be flat woven polypropylene material, 3/4 inch wide, and 900 lb. break strength. Color to be Green. Product to be ArborTie manufactured by Deep Root Partners, L.P. or approved equal.
- B. Stakes shall be lodge pole stakes free of knots and of diameters and lengths appropriate to the size of plant as required to adequately support the plant.
- C. Below ground anchorage systems to be constructed of 2 x 2 dimensional untreated wood securing (using 3 inch long screws) horizontal portions to 4 feet long vertical stakes driven straight into the ground outside the root ball.
- D. Submit manufacturer's product data for approval.

2.7 WATERING BAGS

- A. Plastic tree watering bags holding a minimum of 15 gallons of water and with a slow drip hole(s) water release system, specifically designed to water establishing trees. Water should release over a several day period, not within a few hours
- B. Watering bags shall be:
 - 1. Tregator Irrigation Bags sized to the appropriate model for the requirements of the plant, manufactured by Spectrum Products, Inc., Youngsville, NC 27596.
 - 2. Ooze Tube sized to the appropriate model for the requirements of the plant, manufactured by Engineered Water Solutions, Atlanta, GA.
 - 3. Or approved equal.
- C. Submit manufacturer's product data for approval.

2.8 CHEMICAL OR BIOLOGICAL ADDITIVES

- A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

- B. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb. of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb. of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

PART 3 – EXECUTION

3.1 SITE EXAMINATION

- A. Examine the surface grades and soil conditions to confirm that the requirements of the Specification Section – Planting Soil - and the soil and drainage modifications indicated on the Planting Soil Plan and Details (if applicable) have been completed. Notify the Owner's Representative in writing of any unsatisfactory conditions.

3.2 DELIVERY, STORAGE AND HANDLING

- A. Protect materials from deterioration during delivery and storage. Adequately protect plants from drying out, exposure of roots to sun, wind or extremes of heat and cold temperatures. If planting is delayed more than 24 hours after delivery, set plants in a location protected from sun and wind. Provide adequate water to the root ball package during the shipping and storage period.
 - 1. All plant materials must be available for observation prior to planting.
 - 2. Using a soil moisture meter, periodically check the soil moisture in the root balls of all plants to assure that the plants are being adequately watered. Volumetric soil moisture shall be maintained above wilting point and below field capacity for the root ball substrate or soil.
- B. Do not deliver more plants to the site than there is space with adequate storage conditions. Provide a suitable remote staging area for plants and other supplies.
 - 1. The Owner's Representative or Contractor shall approve the duration, method and location of storage of plants.
- C. Provide protective covering over all plants during transporting.

3.3 PLANTING SEASON

- A. Planting shall only be performed when weather and soil conditions are suitable for planting the materials specified in accordance with locally accepted practice. Install plants during the planting time as described below unless otherwise approved in writing by the Owner's Representative. In the event that the Contractor request planting outside the dates of the planting season, approval of the request does not change the requirements of the warranty.
 - 1. Deciduous trees and shrubs: Spring - April 1 to June 15; Fall - October 15 to November 30. Dig and install plant materials while dormant in spring or fall or after leaves have fully expanded and hardened off.
 - 2. Evergreen trees and shrubs: Spring - April 1 to June 15; Fall - September 15 to October 31. Do not move freshly dug evergreen material without proper conditioning during active growth.
 - 3. Perennial Material: April 1 to November 30.

3.4 ADVERSE WEATHER CONDITIONS

- A. No planting shall take place during extremely hot, dry, windy or freezing weather.

3.5 COORDINATION WITH PROJECT WORK

- A. The Contractor shall coordinate with all other work that may impact the completion of the work.
- B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.
- C. Coordinate the relocation of any irrigation lines, heads or the conduits of other utility lines that are in conflict with tree locations. Root balls shall not be altered to fit around lines. Notify the Owner's Representative of any conflicts encountered.

3.6 LAYOUT AND PLANTING SEQUENCE

- A. Relative positions of all plants and trees are subject to approval of the Owner's Representative.
- B. Notify the Owner's Representative, one (1) week prior to layout. Layout all individual tree and shrub locations. Place plants above surface at planting location or place a labeled stake at planting location. Layout bed lines with paint for the Owner's Representative's approval. Secure the Owner's Representative's acceptance before digging and start of planting work.
- C. When applicable, plant trees before other plants are installed.
- D. It is understood that plants are not precise objects and that minor adjustments in the layout will be required as the planting plan is constructed. These adjustments may not be apparent until some or all of the plants are installed. Make adjustments as required by the Owner's Representative including relocating previously installed plants.

3.7 SOIL PROTECTION DURING PLANT DELIVERY AND INSTALLATION

- A. Protect soil from compaction during the delivery of plants to the planting locations, digging of planting holes and installing plants.
 - 1. Where possible deliver and plant trees that require the use of heavy mechanized equipment prior to final soil preparation and tilling. Where possible, restrict the driving lanes to one area instead of driving over and compacting a large area of soil.
 - 2. Till to a depth of 6 inches, all soil that has been driven over during the installation of plants.

3.8 SOIL MOISTURE

- A. Volumetric soil moisture level, in both the planting soil and the root balls of all plants, prior to, during and after planting shall be above permanent wilting point and below field capacity for each type of soil texture within the following ranges.

Soil type	Permanent wilting point	Field capacity
Sand, Loamy sand, Sandy loam	5-8%	12-18%
Loam, Sandy clay, Sandy clay loam	14-25%	27-36%
Clay loam, Silt loam	11-22%	31-36%
Silty clay, Silty clay loam	22-27%	38-41%

1. Volumetric soil moisture shall be measured with a digital moisture meter. The meter shall be the Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equivalent.
- B. The Contractor shall confirm the soil moisture levels with a moisture meter. If the moisture is too high, suspend planting operations until the soil moisture drains to below field capacity.

3.9 INSTALLATION OF PLANTS: GENERAL

- A. Installation plan shall be submitted a minimum of 14 days prior to the scheduled installation. Plan should describe the methods, activities, materials and schedule to achieve installation of plants.
- B. Observe each plant after delivery and prior to installation for damage of other characteristics that may cause rejection of the plant. Notify the Owner's Representative of any condition observed.
- C. No more plants shall be distributed about the planting bed area than can be planted and watered on the same day.
- D. The root system of each plant, regardless of root ball package type, shall be observed by the Contractor, at the time of planting to confirm that the roots meet the requirements for plant root quality in Part 2 Products: Plants General: Plant Quality. The Contractor shall undertake at the time of planting, all modifications to the root system required by the Owner's Representative to meet these quality standards.
 1. Modifications, at the time of planting, to meet the specifications for the depth of the root collar and removal of stem girdling roots and circling roots may make the plant unstable or stress the plant to the point that the Owner's Representative may choose to reject the plant rather than permitting the modification.
 2. Any modifications required by the Owner's Representative to make the root system conform to the plant quality standards outlined in Part 2 Products: Plants General: Quality, or other requirements related to the permitted root ball package, shall not be considered as grounds to modify or void the plant warranty.
 3. The resulting root ball may need additional staking and water after planting. The Owner's Representative may reject the plant if the root modification process makes the tree unstable or if the tree is not healthy at the end of the warranty period. Such plants shall still be covered under the warranty
 4. The Contractor remains responsible to confirm that the grower has made all required root modifications noted during any nursery observations.
- E. Container and Boxed Root Ball Shaving: The outer surfaces of ALL plants in containers and boxes, including the top, sides and bottom of the root ball shall be shaved to remove all circling, descending, and matted roots. Shaving shall be performed using saws, knives, sharp shovels or other suitable equipment that is capable of making clean cuts on the roots. Shaving shall remove a minimum of one inch of root mat or up to 2 inches as required to remove all root segments that are not growing reasonably radial to the trunk.
- F. Exposed Stem Tissue after Modification: The required root ball modifications may result in stem tissue that has not formed trunk bark being exposed above the soil line. If such condition occurs, wrap the exposed portion of the stem in a protective wrapping with a white filter fabric. Secure the fabric with biodegradable masking tape. DO NOT USE string, twine, green nursery ties or any other material that may girdle the trunk if not removed.

- G. Excavation of the Planting Space: Using hand tools or tracked mini-excavator, excavate the planting hole into the Planting Soil to the depth of the root ball measured after any root ball modification to correct root problems, and wide enough for working room around the root ball or to the size indicated on the drawing or as noted below.
1. For trees and shrubs planted in soil areas that are NOT tilled or otherwise modified to a depth of at least 12 inches over a distance of more than 10 feet radius from each tree, or 5 feet radius from each shrub, the soil around the root ball shall be loosened as defined below or as indicated on the drawings.
 - a. The area of loosening shall be a minimum of 3 times the diameter of the root ball at the surface sloping to 2 times the diameter of the root ball at the depth of the root ball.
 - b. Loosening is defined as digging into the soil and turning the soil to reduce the compaction. The soil does not have to be removed from the hole, just dug, lifted and turned. Lifting and turning may be accomplished with a tracked mini excavator, or hand shovels.
 2. If an auger is used to dig the initial planting hole, the soil around the auger hole shall be loosened as defined above for trees and shrubs planted in soil areas that are NOT tilled or otherwise modified.
 3. The measuring point for root ball depth shall be the average height of the outer edge of the root ball after any required root ball modification.
 4. If motorized equipment is used to deliver plants to the planting area over exposed planting beds, or used to loosen the soil or dig the planting holes, all soil that has been driven over shall be tilled to a depth of 6 inches.
- H. For trees to be planted in prepared Planting Soil that is deeper than the root ball depth, compact the soil under the root ball using a mechanical tamper to assure a firm bedding for the root ball. If there is more than 12 inches of planting soil under the root ball excavate and tamp the planting soil in lifts not to exceed 12 inches.
- I. Set top outer edge of the root ball at the average elevation of the proposed finish. Set the plant plumb and upright in the center of the planting hole. The tree graft, if applicable, shall be visible above the grade. Do not place soil on top of the root ball.
- J. The Owner's Representative may request that plants orientation be rotated when planted based on the form of the plant.
- K. Backfill the space around the root ball with the same planting soil or existing soil that was excavated for the planting space. See Specification Section Planting Soil, for requirements to modify the soil within the planting bed.
- L. Brace root ball by tamping Planting Soil around the lower portion of the root ball. Place additional Planting Soil around base and sides of ball in six-inch (6") lifts. Lightly tamp each lift using foot pressure or hand tools to settle backfill, support the tree and eliminate voids. DO NOT over compact the backfill or use mechanical or pneumatic tamping equipment. Over compaction shall be defined as greater than 85% of maximum dry density, standard proctor or greater than 250 psi as measured by a cone penetrometer when the volumetric soil moisture is lower than field capacity.
1. When the planting hole has been backfilled to three quarters of its depth, water shall be poured around the root ball and allowed to soak into the soil to settle the soil. Do not flood the planting space. If the soil is above field capacity, allow the soil to drain to below field capacity before finishing the planting. Air pockets shall be eliminated and backfill continued until the planting soil is brought to grade level.

- M. Where indicated on the drawings, build a 4 inch high, level berm of Planting Soil around the outside of the root ball to retain water. Tamp the berm to reduce leaking and erosion of the saucer.
- N. Thoroughly water the Planting Soil and root ball immediately after planting.
- O. Remove all nursery plant identification tags and ribbons as per Owner's Representative instructions. The Owner's Representative's seals are to remain on plants until the end of the warranty period.
- P. Remove corrugated cardboard trunk protection after planting.
- Q. Follow additional requirements for the permitted root ball packages.

3.10 PERMITTED ROOT BALL PACKAGES AND SPECIAL PLANTING REQUIREMENTS

- A. The following are permitted root ball packages and special planting requirements that shall be followed during the planting process in addition to the above General planting requirements.

B. BALLED AND BURLAPPED PLANTS

- 1. After the root ball has been backfilled, remove all twine and burlap from the top of the root ball. Cut the burlap away; do not fold down onto the Planting Soil.
- 2. If the plant is shipped with a wire basket that does not meet the requirements of a "Low Rise" basket, remove the top 6 - 8 inches of the basket wires just before the final backfilling of the tree.
- 3. Earth root balls shall be kept intact except for any modifications required by the Owner's Representative to make root package comply with the requirement in Part 2 Products.

C. SPADE HARVESTED AND TRANSPLANTED PLANTS

- 1. After installing the tree, loosen the soil along the seam between the root ball and the surrounding soil out to a radius from the root ball edge equal to the diameter of the root ball to a depth of 8 - 10 inches by hand digging to disturb the soil interface.
- 2. Fill any gaps below this level with loose soil.

D. CONTAINER (INCLUDES BOXED AND ABOVE-GROUND FABRIC CONTAINERS) PLANTS

- 1. This specification assumes that most container plants have significant stem girdling and circling roots, and that the root collar is too low in the root ball.
- 2. Remove the container.
- 3. Perform root ball shaving as defined in Installation of Plants: General above.
- 4. Remove all roots and substrate above the root collar and the main structural roots according to root correction details so root system conforms to root observations detail.
- 5. Remove all substrate at the bottom of the root ball that does not contain roots.
- 6. Using a hose, power washer or air excavation device, wash out the substrate from around the trunk and top of the remaining root ball and find and remove all stem girdling roots within the root ball above the top of the structural roots.

E. BARE ROOT PLANTS

1. Dig the planting hole to the diameter of the spread of the roots to a depth in the center that maintains the root collar at the elevation of the surrounding finished grade and slightly deeper along the edges of the hole.
2. Spread all roots out radial to the trunk in the prepared hole making the hole wider where needed to accommodate long roots. Root tips shall be directed away from the trunk. Prune any broken roots removing the least amount of tissue possible.
3. Maintain the trunk plumb while backfilling soil around the roots.
4. Lightly tamp the soil around the roots to eliminate voids and reduce settlement.

F. IN-GROUND FABRIC CONTAINERS

1. Remove the fabric container from the root ball. Cut roots at the edge of the container as needed to extract the fabric from the roots. Make clean cuts with sharp tools; do not tear roots away from the fabric.
2. Observe the root system after the container is removed to confirm that the root system meets the quality standards.

3.11 GROUND COVER, PERENNIAL AND ANNUAL PLANTS

- A. Assure that soil moisture is within the required levels prior to planting. Irrigation, if required, shall be applied at least 12 hours prior to planting to avoid planting in muddy soils.
- B. Assure that soil grades in the beds are smooth and as shown on the plans.
- C. Plants shall be planted in even, triangularly spaced rows, at the intervals called out for on the drawings, unless otherwise noted. The first row of Annual flower plants shall be 6 inches from the bed edge unless otherwise directed.
- D. Dig planting holes sufficiently large enough to insert the root system without deforming the roots. Set the top of the root system at the grade of the soil.
- E. Schedule the planting to occur prior to application of the mulch. If the bed is already mulched, pull the mulch from around the hole and plant into the soil. Do not plant the root system in the mulch. Pull mulch back so it is not on the root ball surface.
- F. Press soil to bring the root system in contact with the soil.
- G. Spread any excess soil around in the spaces between plants.
- H. Apply mulch to the bed being sure not to cover the tops of the plants with or the tops of the root ball with mulch.
- I. Water each planting area as soon as the planting is completed. Apply additional water to keep the soil moisture at the required levels. Do not over water.

3.12 STAKING AND GUYING

- A. Do not stake or guy trees unless specifically required by the Contract Documents, or in the event that the Contractor feels that staking is the only alternative way to keep particular trees plumb.
 1. The Owner's Representative shall have the authority to require that trees are staked or to reject staking as an alternative way to stabilize the tree.
 2. Trees that required heavily modified root balls to meet the root quality standards may become unstable. The Owner's Representative may choose to reject these trees rather

than utilize staking to temporarily support the tree.

- B. Trees that are guyed shall have their guys and stakes removed after one full growing season or at other times as required by the Owner's Representative.
- C. Tree guying shall utilize the tree staking and guying materials specified. Guying to be tied in such a manner as to create a minimum 12-inch loop to prevent girdling. Refer to manufacturer's recommendations and the planting detail for installation.
 - 1. Plants shall stand plumb after staking or guying.
 - 2. Stakes shall be driven to sufficient depth to hold the tree rigid.
- D. For trees planted in planting mix over waterproofed membrane, use dead men buried 24 inches to the top of the dead man, in the soil. Tie the guy to the dead man with a double wrap of line around the dead man followed by a double half hitch. When guys are removed, leave the dead men in place and cut the guy tape 12 inches above the ground, leaving the tape end covered in mulch.

3.13 STRAIGHTENING PLANTS

- A. Maintain all plants in a plumb position throughout the warranty period. Straighten all trees that move out of plumb including those not staked. Plants to be straightened shall be excavated and the root ball moved to a plumb position, and then re-backfilled.
- B. Do not straighten plants by pulling the trunk with guys.

3.14 INSTALLATION OF FERTILIZER AND OTHER CHEMICAL ADDITIVES

- A. Do not apply any soluble fertilizer to plantings during the first year after transplanting unless soil test determines that fertilizer or other chemical additives is required. Apply chemical additives only upon the approval of the Owner's Representative.
- B. Controlled release fertilizers shall be applied according to the manufacturer's instructions and standard horticultural practices.

3.15 PRUNING OF TREES AND SHRUBS

- A. Prune plants as directed by the Owner's Representative. Pruning trees shall be limited to addressing structural defects as shown in details; follow recommendations in "Structural Pruning: A Guide For The Green Industry" published by Urban Tree Foundation, Visalia CA.
- B. All pruning shall be performed by a person experienced in structural tree pruning.
- C. Except for plants specified as multi-stemmed or as otherwise instructed by the Owner's Representative, preserve or create a central leader.
- D. Pruning of large trees shall be done using pole pruners or if needed, from a ladder or hydraulic lift to gain access to the top of the tree. Do not climb in newly planted trees. Small trees can be structurally pruned by laying them over before planting. Pruning may also be performed at the nursery prior to shipping.
- E. Remove and replace excessively pruned or malformed stock resulting from improper pruning that occurred in the nursery or after.
- F. Pruning shall be done with clean, sharp tools.
- G. No tree paint or sealants shall be used.

3.16 MULCHING OF PLANTS

- A. Apply 3 inches of mulch before settlement, covering the entire planting bed area. Install no more than 1 inch of mulch over the top of the root balls of all plants. Taper to 2 inches when abutting pavement.
- B. For trees planted in lawn areas the mulch shall extend to a 5 foot radius around the tree or to the extent indicated on the plans.
- C. Lift all leaves, low hanging stems and other green portions of small plants out of the mulch if covered.

3.17 PLANTING BED FINISHING

- A. After planting, smooth out all grades between plants before mulching.
- B. Separate the edges of planting beds and lawn areas with a smooth, formed edge cut into the turf with the bed mulch level slightly lower, 1 and 2 inches, than the adjacent turf sod or as directed by the Owner's Representative. Bed edge lines shall be as depicted on the drawings.

3.18 WATERING

- A. The Contractor shall be fully responsible to ensure that adequate water is provided to all plants from the point of installation until the date of Substantial Completion Acceptance. The Contractor shall adjust the automatic irrigation system, if available, and apply additional or adjust for less water using hoses as required.
- B. Hand water root balls of all plants to assure that the root balls have moisture above wilt point and below field capacity. Test the moisture content in each root ball and the soil outside the root ball to determine the water content.
- C. The Contractor shall install 25 gallon watering bag for each tree to be maintained and used for tree watering during the warranty period.
 - 1. The watering bags shall remain the property of the Owner at the completion of the work.

3.19 CLEAN-UP

- A. During installation, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.
 - 1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.
- B. Once installation is complete, wash all soil from pavements and other structures. Ensure that mulch is confined to planting beds and that all tags and flagging tape are removed from the site. The Owner's Representative's seals are to remain on the trees and removed at the end of the warranty period.
- C. Make all repairs to grades, ruts, and damage by the plant installer to the work or other work at the site.
- D. Remove and dispose of all excess planting soil, subsoil, mulch, plants, packaging, and other material brought to the site by the Contractor.

3.20 PROTECTION DURING CONSTRUCTION

- A. The Contractor shall protect planting and related work and other site work from damage due to planting operations, operations by other Contractors or trespassers. Maintain protection

during installation until Substantial Completion Acceptance. Treat, repair or replace damaged work immediately.

- B. Damage done by the Contractor, or any of their sub-contractors to existing or installed plants, or any other parts of the work or existing features to remain, including roots, trunk or branches of large existing trees, soil, paving, utilities, lighting, irrigation, other finished work and surfaces including those on adjacent property, shall be cleaned, repaired or replaced by the Contractor at no expense to the Owner. The Owner's Representative shall determine when such cleaning, replacement or repair is satisfactory.

3.21 PLANT MAINTENANCE PRIOR TO SUBSTANTIAL COMPLETION ACCEPTANCE

- A. During the project work period and prior to Substantial Completion Acceptance, the Contractor shall maintain all plants.
- B. Maintenance during the period prior to Substantial Completion Acceptance shall consist of pruning, watering, cultivating, weeding, mulching, removal of dead material, repairing and replacing of tree stakes, tightening and repairing of guys, repairing and replacing of damaged tree wrap material, resetting plants to proper grades and upright position, and furnishing and applying such sprays as are necessary to keep plantings reasonably free of damaging insects and disease, and in healthy condition. The threshold for applying insecticides and herbicide shall follow established Integrated Pest Management (IPM) procedures. Mulch areas shall be kept reasonably free of weeds, grass.

3.22 SUBSTANTIAL COMPLETION ACCEPTANCE

- A. Upon written notice from the Contractor, the Owners Representative shall review the work and make a determination if the work is substantially complete.
 - 1. Notification shall be at least 7 days prior to the date the contractor is requesting the review.
- B. The date of substantial completion of the planting shall be the date when the Owner's Representative accepts that all work in Planting, Planting Soil, and Irrigation installation sections is complete.
- C. The Plant Warranty period begins at date of written notification of substantial completion from the Owner's Representative. The date of substantial completion may be different than the date of substantial completion for the other sections of the project.

3.23 MAINTENANCE DURING THE WARRANTY PERIOD BY THE PLANT INSTALLER

- A. During the warranty period, provide all maintenance for all plantings to keep the plants in a healthy state and the planting areas clean and neat.
- B. General requirements:
 - 1. All work shall be undertaken by trained planting crews under the supervision of a foreman with a minimum of 5 years of experience supervising commercial plant maintenance crews.
 - 2. All chemical and fertilizer applications shall be made by licensed applicators for the type of chemicals to be used. All work and chemical use shall comply with all applicable local, provincial and federal requirements.
 - 3. Assure that hoses and watering equipment and other maintenance equipment does not block paths or be placed in a manner that may create tripping hazards. Use standard safety warning barriers and other procedures to maintain the site in a safe manner for visitors at all times.

4. All workers shall wear required safety equipment and apparel appropriate for the tasks being undertaken.
 5. The Contractor shall not store maintenance equipment at the site at times when they are not in use unless authorized in writing by the Owner's Representative.
 6. Maintenance vehicles shall not park on the site including walks and lawn areas at any time without the Owner's Representative's written permission.
 7. Maintain a detailed log of all maintenance activities including types of tasks, date of task, types and quantities of materials and products used, watering times and amounts, and number of each crew. Periodically review the logs with the Owner's Representative, and submit a copy of the logs at the end of each year of the maintenance agreement.
 8. Meet with the Owner's Representative a minimum of three times a year to review the progress and discuss any changes that are needed in the maintenance program. At the end of the warranty period attend a hand over meeting to formally transfer the responsibilities of maintenance to the Owner's Representative. Provide all information on past maintenance activities and provide a list of critical tasks that will be needed over the next 12 months. Provide all maintenance logs and soil test data. Make the Contractor's supervisor available for a minimum of one year after the end of the warranty period to answer questions about past maintenance.
- C. Provide the following maintenance tasks:
1. Watering; Provide all water required to keep soil within and around the root balls at optimum moisture content for plant growth.
 - a. Maintain all watering systems and equipment and keep them operational.
 - b. Monitor soil moisture to provide sufficient water. Check soil moisture and root ball moisture with a soil moisture meter on a regular basis and record moisture readings. Do not over water.
 2. Soil nutrient levels: Take a minimum of 4 soil samples from around the site in the spring and fall and have them tested by an accredited agricultural soil testing lab for chemical composition of plant required nutrients, pH, salt and % organic matter. Test results shall include laboratory recommendations for nutrient applications. Apply fertilizers at rates recommended by the soil test.
 - a. Make any other soil test and/or plant tissue test that may be indicated by plant conditions that may not be related to soil nutrient levels such as soil contaminated by other chemicals or lack of chemical uptake by the plant.
 3. Plant pruning: Remove cross over branching, shorten or remove developing co dominant leaders, dead wood and winter-damaged branches. Unless directed by the Owner's Representative, do not shear plants or make heading cuts.
 4. Restore plants: Reset any plants that have settled or are leaning as soon as the condition is noticed.
 5. Guying and staking: Maintain plant guys in a taught position. Remove tree guys and staking after the first full growing season unless directed by Owner's Representative.
 6. Weed control: Keep all beds free of weeds. Hand-remove all weeds and any plants that do not appear on the planting plan. Chemical weed control is permitted only with the approval of the Owner's Representative. Schedule weeding as needed but not less *4 times per year*.
 7. Trash removal: Remove all trash and debris from all planting beds and maintain the beds in a neat and tidy appearance. The number of trash and debris removal visits shall be no less than 4 times per year and may coincide with other maintenance visits.
 8. Plant pest control: Maintain disease, insects and other pests at manageable levels. Manageable levels shall be defined as damage to plants that may be noticeable to a professional but not to the average person. Use least invasive methods to control plant disease and insect outbreaks.

- a. The Owner's Representative must approve in advance the use of all chemical pesticide applications.
9. Plant replacement: Replace all plants that are defective as defined in the warranty provisions, as soon as the plant decline is obvious and in suitable weather and season for planting as outlined in above sections. Plants that become defective during the maintenance period shall be covered and replaced under the warranty provisions.
10. Mulch: Refresh mulch once a year to maintain complete coverage but do not over mulch. At no time shall the overall mulch thickness be greater than 3 inches. Do not apply mulch within 6 inches of the trunks or stems of any plants. Replacement mulch shall meet the requirements of the original approved material. Mulch shall be no more than one inch on top of the root ball surface.
11. Bed edging: Check and maintain edges between mulch and lawn areas in smooth neat lines as originally shown on the drawings.
12. Leaf, fruit and other plant debris removal: Remove fall leaf, spent flowers, fruit and plant part accumulations from beds and paved surfaces. Maintain all surface water drains free of debris. Debris removal shall be undertaken at each visit to weed or pick up trash in beds.
13. Damage from site use: Repair of damage by site visitors and events, beyond normal wear, are not part of this maintenance. The Owner's Representative may request that the Contractor repair damage beds or plantings for an additional cost. All additional work shall be approved in advance by the Owner's Representative.

3.24 END OF WARRANTY FINAL ACCEPTANCE / MAINTENANCE OBSERVATION

- A. At the end of the Warranty and Maintenance period the Owner's Representative shall observe the work and establish that all provisions of the contract are complete and the work is satisfactory.
 1. If the work is satisfactory, the maintenance period will end on the date of the final observation.
 2. If the work is deemed unsatisfactory, the maintenance period will continue at no additional expense to the Owner until the work has been completed, observed, and approved by the Owner's Representative.
- B. FAILURE TO PASS OBSERVATION: If the work fails to pass final observation, any subsequent observations must be rescheduled as per above. The cost to the Owner for additional observations will be charged to the Contractor at the prevailing hourly rate of the Owners Representative.

END OF SECTION 329300

SECTION 330500 - COMMON WORK RESULTS FOR UTILITIES

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. This Section includes the following:
 - 1. Piping joining materials.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Sleeves.
 - 5. Identification devices.
 - 6. Grout.
 - 7. Flowable fill.
 - 8. Piped utility demolition.
 - 9. Piping system common requirements.
 - 10. Equipment installation common requirements.
 - 11. Painting.
 - 12. Concrete bases.
 - 13. Metal supports and anchorages.

1.3 DEFINITIONS

- A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
- B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- C. ABS: Acrylonitrile-butadiene-styrene plastic.
- D. CPVC: Chlorinated polyvinyl chloride plastic.
- E. PE: Polyethylene plastic.
- F. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Dielectric fittings.
 - 2. Identification devices.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. 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.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.8 COORDINATION

- A. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- B. Coordinate installation of identifying devices after completing covering and painting if devices are applied to surfaces.
- C. Coordinate size and location of concrete bases. Formwork, reinforcement, and concrete requirements are specified in Section 033000 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness, unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAgl, silver alloy for refrigerant piping, unless otherwise indicated.
- F. 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.
- G. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.
- H. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.2 TRANSITION FITTINGS

- A. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
- B. Transition Couplings NPS 1-1/2 (DN 40) and Smaller:
 - 1. Underground Piping: Manufactured piping coupling or specified piping system fitting.
 - 2. Aboveground Piping: Specified piping system fitting.

- C. AWWA Transition Couplings NPS 2 (DN 50) and Larger:
 - 1. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.
- D. Plastic-to-Metal Transition Fittings:
 - 1. Description: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint[or threaded] end.
- E. Plastic-to-Metal Transition Unions:
 - 1. Description: MSS SP-107, CPVC and PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.
- F. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:
 - 1. Description: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.3 DIELECTRIC FITTINGS

- A. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Unions:
 - 1. Description: Factory fabricated, union, NPS 2 (DN 50) and smaller.
 - a. Pressure Rating: 150 psig (1035 kPa) minimum
 - b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.
- C. Dielectric Flanges:
 - 1. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and larger.
 - a. Pressure Rating: 150 psig (1035 kPa) minimum
 - b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Kits:
 - 1. Description: Nonconducting materials for field assembly of companion flanges, NPS 2-1/2 (DN 65) and larger.
 - a. Pressure Rating: 150 psig (1035 kPa) minimum
 - b. Gasket: Neoprene or phenolic.
 - c. Bolt Sleeves: Phenolic or polyethylene.
 - d. Washers: Phenolic with steel backing washers.
- E. Dielectric Couplings:
 - 1. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, NPS 3 (DN 80) and smaller.

- a. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
- b. End Connections: Threaded.

F. Dielectric Nipples:

1. Description: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.
 - a. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
 - b. End Connections: Threaded or grooved.

2.4 SLEEVES

- A. Mechanical sleeve seals for pipe penetrations are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- B. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, plain ends.
- D. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- E. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
- G. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.5 IDENTIFICATION DEVICES

- A. General: Products specified are for applications referenced in other utilities Sections. If more than single type is specified for listed applications, selection is Installer's option.
- B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
 1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
 2. Location: Accessible and visible.
- C. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is 1-1/4 inches (30 mm) for ducts, and 3/4 inch (20 mm) for access door signs and similar operational instructions.
 1. Material: Brass.
 2. Stencil Paint: Exterior, oil-based, alkyd-gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
 3. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.

- D. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.
- E. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.
- F. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Full-band pipe markers, extending 360 degrees around pipe at each location.
- G. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.
- H. Lettering: Manufacturer's standard preprinted captions as selected by Architect.
- I. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 - 1. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.
- J. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils (0.08 mm) thick.
 - 1. Width: 1-1/2 inches (40 mm) on pipes with OD, including insulation, less than 6 inches (150 mm); 2-1/2 inches (65 mm) for larger pipes.
 - 2. Color: Comply with ASME A13.1, unless otherwise indicated.
- K. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) sequenced numbers. Include 5/32-inch (4-mm) hole for fastener.
 - 1. Material: 0.032-inch- (0.8-mm-) thick, polished brass or aluminum.
 - 2. Material: 0.0375-inch- (1-mm-) thick stainless steel.
 - 3. Material: 3/32-inch- (2.4-mm-) thick plastic laminate with 2 black surfaces and a white inner layer.
 - 4. Material: Valve manufacturer's standard solid plastic.
 - 5. Size: 1-1/2 inches (40 mm) in diameter, unless otherwise indicated.
 - 6. Shape: As indicated for each piping system.
- L. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.
- M. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
 - 1. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
 - 2. Thickness: 1/8 inch (3 mm), unless otherwise indicated.
 - 3. Thickness: 1/16 inch (1.6 mm), for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) in length, and 1/8 inch (3 mm) for larger units.
 - 4. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.

- N. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:
1. Green: Cooling equipment and components.
 2. Yellow: Heating equipment and components.
 3. Brown: Energy reclamation equipment and components.
 4. Blue: Equipment and components that do not meet criteria above.
 5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
 6. Terminology: Match schedules as closely as possible. Include the following:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
 7. Size: 2-1/2 by 4 inches (65 by 100 mm) for control devices, dampers, and valves; 4-1/2 by 6 inches (115 by 150 mm) for equipment.
- O. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.
1. Size: 3-1/4 by 5-5/8 inches (83 by 143 mm).
 2. Fasteners: Brass grommets and wire.
 3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
- P. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.
1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

2.6 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
1. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

2.7 FLOWABLE FILL

- A. Description: Low-strength-concrete, flowable-slurry mix.
1. Cement: ASTM C 150, Type I, portland.

2. Density: [115- to 145-lb/cu. ft. (1840- to 2325-kg/cu. m)] <Insert value>.
3. Aggregates: ASTM C 33, natural sand, fine and crushed gravel or stone, coarse.
4. Aggregates: ASTM C 33, natural sand, fine.
5. Admixture: ASTM C 618, fly-ash mineral.
6. Water: Comply with ASTM C 94/C 94M.
7. Strength: [100 to 200 psig (690 to 1380 kPa)] <Insert value> at 28 days.

PART 3 - EXECUTION

3.1 PIPED UTILITY DEMOLITION

- A. Refer to Section 024119 "Selective Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.
 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 2. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 DIELECTRIC FITTING APPLICATIONS

- A. Dry Piping Systems: Connect piping of dissimilar metals with the following:
 1. NPS 2 (DN 50) and Smaller: Dielectric unions.
 2. NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Dielectric flanges or dielectric flange kits.
- B. Wet Piping Systems: Connect piping of dissimilar metals with the following:
 1. NPS 2 (DN 50) and Smaller: Dielectric couplings or dielectric nipples.
 2. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric nipples.
 3. NPS 2-1/2 to NPS 8 (DN 65 to DN 200): Dielectric nipples or dielectric flange kits.
 4. NPS 10 and NPS 12 (DN 250 and DN 300): Dielectric flange kits.

3.3 PIPING INSTALLATION

- A. Install piping according to the following requirements and utilities Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements 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 the Coordination Drawings.
- 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 to permit valve servicing.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Select system components with pressure rating equal to or greater than system operating pressure.
- I. Sleeves are not required for core-drilled holes.
- J. Permanent sleeves are not required for holes formed by removable PE sleeves.
- K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
 - b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
- L. Verify final equipment locations for roughing-in.
- M. Refer to equipment specifications in other Sections for roughing-in requirements.

3.4 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.

- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. 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 unless dry seal threading is specified.
 - 2. 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.
- E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- G. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- H. Soldered Joints: Apply ASTM B 813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.
- I. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- J. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.
- K. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- L. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- M. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

- N. Plastic 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 PE Pipe and Fittings: Use butt fusion.
 - 2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.
- O. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.5 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Install dielectric fittings at connections of dissimilar metal pipes.

3.6 EQUIPMENT INSTALLATION

- A. Install equipment level and plumb, unless otherwise indicated.
- B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.
- C. Install equipment to allow right of way to piping systems installed at required slope.

3.7 PAINTING

- A. Painting of piped utility systems, equipment, and components is specified in Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 IDENTIFICATION

- A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
 - 1. Stenciled Markers: According to ASME A13.1.
 - 2. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
 - 3. Locate pipe markers on exposed piping according to the following:

- a. Near each valve and control device.
 - b. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
 - c. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
 - d. At manholes and similar access points that permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
- B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.
1. Lettering Size: Minimum 1/4 inch (6.4 mm) high for name of unit if viewing distance is less than 24 inches (610 mm), 1/2 inch (13 mm) high for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
 2. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

3.9 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) 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 (450-mm) centers around the full perimeter of 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. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 7. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Section 055000 "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.11 GROUTING

- A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 330500

SECTION 334600 - SUBDRAINAGE

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. Perforated-wall pipe and fittings.
 - 2. Drainage conduits.
 - 3. Drainage panels.
 - 4. Geotextile filter fabrics.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Drainage conduits, including rated capacities.
 - 2. Drainage panels, including rated capacities.
 - 3. Geotextile filter fabrics.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

- A. Perforated PE Pipe and Fittings:
 - 1. NPS 6 (DN 150) and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
 - 2. NPS 8 (DN 200) and Larger: ASTM F 667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
 - 3. Couplings: Manufacturer's standard, band type.
- B. Perforated PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.

2.2 DRAINAGE CONDUITS

- A. Molded-Sheet Drainage Conduits: Prefabricated geocomposite with cusped, molded-plastic drainage core wrapped in geotextile filter fabric.

1. Nominal Size: 12 inches (305 mm) high by approximately 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow: 30 gpm (114 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
 2. Nominal Size: 18 inches (457 mm) high by approximately 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow: 45 gpm (170 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
 3. Filter Fabric: PP geotextile.
 4. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.
- B. Multipipe Drainage Conduits: Prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE complying with ASTM D 1248 and wrapped in geotextile filter fabric.
1. Nominal Size: 6 inches (152 mm) high by approximately 1-1/4 inches (31 mm) thick.
 - a. Minimum In-Plane Flow: 15 gpm (57 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
 2. Nominal Size: 12 inches (305 mm) high by approximately 1-1/4 inches (31 mm) thick.
 - a. Minimum In-Plane Flow: 30 gpm (114 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
 3. Nominal Size: 18 inches (457 mm) high by approximately 1-1/4 inches (31 mm) thick.
 - a. Minimum In-Plane Flow: 45 gpm (170 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
 4. Filter Fabric: Nonwoven, needle-punched geotextile.
 5. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.
 6. Couplings: HDPE.
- C. Single-Pipe Drainage Conduits: Prefabricated geocomposite with perforated corrugated core molded from HDPE complying with ASTM D 3350 and wrapped in geotextile filter fabric.
1. Nominal Size: 12 inches (305 mm) high by approximately 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow: 30 gpm (114 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
 2. Nominal Size: 18 inches (457 mm) high by approximately 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow: 45 gpm (170 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
 3. Filter Fabric: PP geotextile.

4. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.
 5. Couplings: Corrugated HDPE band.
- D. Mesh Fabric Drainage Conduits: Prefabricated geocomposite with plastic-filament drainage core wrapped in geotextile filter fabric. Include fittings for bends and connection to drainage piping.
1. Nominal Size: 6 inches (150-mm) high by approximately 0.9 inch (23 mm) thick.
 - a. Minimum In-Plane Flow: 2.4 gpm (9.1 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
 2. Filter Fabric: Nonwoven geotextile made of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.
- E. Ring Fabric Drainage Conduits: Drainage conduit with HDPE rings-in-grid pattern drainage core, for field-applied geotextile filter fabric. Include fittings for bends and connection to drainage piping.
1. Nominal Size: 18 inches (0.5 m) high by 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow: 82 gpm (310 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
 2. Nominal Size: 36 inches (1 m) high by 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow: 164 gpm (621 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
 3. Filter Fabric: Comply with requirements for flat geotextile filter fabric specified in Part 2 "Geotextile Filter Fabrics" Article.

2.3 DRAINAGE PANELS

- A. Molded-Sheet Drainage Panels: Prefabricated geocomposite, 36 to 60 inches (915 to 1525 mm) wide with drainage core faced with geotextile filter fabric.
1. Drainage Core: Three-dimensional, nonbiodegradable, molded PP.
 - a. Minimum Compressive Strength: 18,000 lbf/sq. ft. (862 kPa when tested according to ASTM D 1621.
 - b. Minimum In-Plane Flow Rate: 15 gpm/ft. (186 L/min. per m) of unit width at hydraulic gradient of 1.0 and compressive stress of 25 psig (172 kPa) when tested according to ASTM D 4716.
 2. Filter Fabric: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to AASHTO M 288:
 - a. Survivability: Class 1.

- b. Apparent Opening Size: No. 60 (0.25-mm) sieve, maximum.
 - c. Permittivity: 0.2 per second, minimum.
 3. Filter Fabric: Woven geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation less than 50 percent; complying with the following properties determined according to AASHTO M 288:
 - a. Survivability: Class 1.
 - b. Apparent Opening Size: No. 60 (0.25-mm) sieve, maximum.
 - c. Permittivity: 0.2 per second, minimum.
 4. Film Backing: Polymeric film bonded to drainage core surface.
- B. Mesh Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
 1. Drainage Core: Open-construction, resilient, plastic-filament mesh, approximately 0.4 inches (10.2 mm) thick.
 - a. Minimum In-Plane Flow Rate: 2.4 gpm/ft. (30 L/min. per m) of unit width at hydraulic gradient of 1.0 and normal pressure of 25 psig (172 kPa) when tested according to ASTM D 4716.
 2. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.
- C. Net Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
 1. Drainage Core: Three-dimensional, PE nonwoven-strand geonet, approximately 0.25 inches (6 mm) thick.
 - a. Minimum In-Plane Flow Rate: 5 gpm/ft. (62 L/min. per m) of unit width at hydraulic gradient of 1.0 and normal pressure of 25 psig (172 kPa) when tested according to ASTM D 4716.
 2. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.
- D. Ring Fabric Drainage Panels: Drainage-core panel for field application of geotextile filter fabric.
 1. Drainage Core: Three-dimensional, HDPE rings-in-grid pattern, approximately 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow Rate: 40 gpm/ft. (500 L/min. per m) of unit width at hydraulic gradient of 1.0 and normal pressure of 25 psig (172 kPa) when tested according to ASTM D 4716.

2.4 SOIL MATERIALS

- A. Soil materials are specified in Section 312000 "Earth Moving."

2.5 WATERPROOFING FELTS

- A. Material: Comply with ASTM D 226, Type I, asphalt-saturated organic felt.

2.6 GEOTEXTILE FILTER FABRICS

- A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m) when tested according to ASTM D 4491.
- B. Structure Type: Nonwoven, needle-punched continuous filament.
 - 1. Survivability: AASHTO M 288 Class 2.
 - 2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Verify that drainage panels installed as part of foundation wall waterproofing is properly positioned to drain into subdrainage system.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 FOUNDATION DRAINAGE INSTALLATION

- A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches (150 mm) deep and 12 inches (300 mm) wide.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with tape.
- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.
- F. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
- G. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.
- H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- I. Place layer of waterproofing felt over top of drainage course, overlapping edges at least 4 inches (100 mm).
- J. Install drainage panels on foundation walls as follows:
 - 1. Coordinate placement with other drainage materials.
 - 2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article.
 - 3. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
 - 4. Attach panels to wall beginning at subdrainage pipe. Place and secure molded-sheet drainage panels, with geotextile facing away from wall.
- K. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.4 UNDERSLAB DRAINAGE INSTALLATION

- A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches (150 mm) between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with tape.
- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.

- F. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
- G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Install horizontal drainage panels as follows:
 - 1. Coordinate placement with other drainage materials.
 - 2. Lay perforated drainage pipe at inside edge of footing.
 - 3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
 - 4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

3.5 RETAINING-WALL DRAINAGE INSTALLATION

- A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- B. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 4 inches (100 mm).
- C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with tape.
- D. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.
- E. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
- F. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.
- G. Place drainage course in layers not exceeding 3 inches (75 mm) in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Place layer of waterproofing felt over top of drainage course, overlapping edges at least 4 inches (100 mm).
- I. Install drainage panels on wall as follows:
 - 1. Coordinate placement with other drainage materials.
 - 2. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
 - 3. If weep holes are used instead of drainage pipe, cut 1/2-inch- (13-mm-) diameter holes on core side at weep-hole locations. Do not cut fabric.
 - 4. Mark horizontal chalk line on wall at a point 6 inches (150 mm) less than panel width above footing bottom. Before marking wall, subtract footing width.

5. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
 6. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from 2 to 6 inches (50 to 150 mm) below top of panel, approximately 48 inches (1200 mm) apart. Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
 7. If another panel is required on same row, cut away 4 inches (100 mm) of installed panel core and wrap fabric over new panel.
 8. If additional rows of panel are required, overlap lower panel with 4 inches (100 mm) of fabric.
 9. Cut panel as necessary to keep top 12 inches (300 mm) below finish grade.
 10. For inside corners, bend panel. For outside corners, cut core to provide 3 inches (75 mm) for overlap.
- J. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Fill to finish grade.

3.6 LANDSCAPING DRAINAGE INSTALLATION

- A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
- D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least 6 inches (150 mm) between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with tape.
- E. Add drainage course to top of drainage conduits.
- F. After satisfactory testing, cover drainage conduit to within 12 inches (300 mm) of finish grade.
- G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Place layer of waterproofing felt over top of drainage course, overlapping edges at least 4 inches (100 mm).
- I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Fill to finish grade.

3.7 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
 - 1. Foundation Subdrainage: Install piping level and with a minimum cover of 36 inches (915 mm) unless otherwise indicated.
 - 2. Underslab Subdrainage: Install piping level.
 - 3. Plaza Deck Subdrainage: Install piping level.
 - 4. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of 36 inches (915 mm) unless otherwise indicated.
 - 5. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches (915 mm) unless otherwise indicated.
 - 6. Lay perforated pipe with perforations down.
 - 7. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
- C. Install thermoplastic piping according to ASTM D 2321.

3.8 PIPE JOINT CONSTRUCTION

- A. Join perforated PE pipe and fittings with couplings according to ASTM D 3212 with loose banded, coupled, or push-on joints.
- B. Join perforated PVC sewer pipe and fittings according to ASTM D 3212 with loose bell-and-spigot, push-on joints.
- C. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.9 BACKWATER VALVE INSTALLATION

- A. Comply with requirements for backwater valves specified in Section 334100 "Storm Utility Drainage Piping."
- B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.
- C. Install horizontal backwater valves in piping in manholes or pits where indicated.

3.10 CLEANOUT INSTALLATION

- A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."
- B. Cleanouts for Foundation, Retaining-Wall, and, Landscaping Subdrainage:
 - 1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
 - 2. In vehicular-traffic areas, use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set top of cleanout flush with grade.
 - 3. In nonvehicular-traffic areas, use NPS 4 (DN 100) PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches (300 by 300 by 100 mm) deep. Set top of cleanout 2 inches (50 mm) above grade.
 - 4. Comply with requirements for concrete specified in Section 033000 "Cast-in-Place Concrete."
- C. Cleanouts for Underslab Subdrainage:
 - 1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
 - 2. Use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.11 CONNECTIONS

- A. Comply with requirements for piping specified in Section 334100 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect low elevations of subdrainage system to building's solid-wall-piping storm drainage system.
- C. Where required, connect low elevations of foundation subdrainage to stormwater sump pumps. Comply with requirements for sump pumps specified in Section 221429 "Sump Pumps."

3.12 IDENTIFICATION

- A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 312000 "Earth Moving."
 - 1. Install PE warning tape or detectable warning tape over ferrous piping.
 - 2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.13 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

B. Drain piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.14 CLEANING

- A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 334600