PROJECT MANUAL

Robert Poole Building #056
Additions and Renovations

March 31, 2016

VOLUME 2 – DIVISIONS 21-33

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TABLE OF CONTENTS

VOLUME 2

END OF TABLE OF CONTENTS

SECTION 21 05 00 – COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 STIPULATIONS

A. General provisions of the Contract Documents including General and Supplementary Conditions and Division 1 Specifications Sections apply to all work in this section.

B. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 WORK INCLUDED

A. This specification applies to the installation of the automatic sprinkler system at Robert Poole Building #056. This specification provides general items related to the fire protection work.

B. Within the scope of work for this project, the Contractor shall:

1. Provide a complete automatic sprinkler system in the building. Refer to Section 21 13 13 and the drawings.

2. Provide a complete manual wet standpipe system in the building including roof hydrants. Refer to Section 21 13 13 and the drawings.

3. Provide a fire pump, jockey pump, and associated controls. Refer to Section 21 30 00 - Fire Pumps and the drawings.

1.3 DEFINITIONS

A. The Authority Having Jurisdiction (AHJ) and other project supervisors are defined as:

1. AHJ: Baltimore City and Maryland Stadium Authority

2. Fire Marshal: Baltimore City Fire Department – Fire / Code Enforcement

3. Owner: Baltimore City Public Schools

4. Professional: Brinjac Engineering, Inc., JRS Architects, Inc.

5. Construction Manager (CM): Baltimore City Public Schools Facilities Design and Construction

6. Insurance Carrier: Agent for the Owner that provides insurance coverage for the project

B. The following words are defined as:

1. Contractor: In this section shall refer to the Fire Protection Contractor.

2. Provide: Includes the furnishing and installation of a device or system.

1.4 APPROVALS

A. The Contractor must comply with all laws, ordinances, and regulations of all Authorities Having Jurisdiction (AHJ), including Borough, County, State, Federal, Public Utility, and the Owner's insurance carrier.

B. Hydraulic calculations, product data sheets, shop drawings and all other associated submittals must bear the stamp of approval of the AHJ. Provide NFPA 13 working plans to the AHJ. Any and all comments received from the AHJ and resolution thereof shall be submitted to the Professional for record.

C. The Contractor is responsible for all fees associated with the required approvals.

1.5 SUBMITTALS

A. Refer to any front end specifications for additional detailed requirements regarding shop drawings, product data, and samples.

B. The Contractor shall be responsible for all fees associated with the AHJ, Insurance Carrier and/or Professional's reviews.

C. The submittal shall be made as a complete package consisting of fire protection equipment ONLY. The submittal shall NOT include other plumbing equipment or components not directly related to the fire protection system installation for approval. Where other equipment or components are an integral part of the fire protection system, they shall be indicated as such, but not included with the submittal and only show required interface details. Failure to submit all required materials as a complete, separate single package shall be cause for rejection of entire package. Copies of the Contract Documents with contractor's notes thereon will be rejected. Simply redlining the Contract Documents is not acceptable.

D. Refer to the individual sections for additional submittal requirements, including identified equipment and materials for which submittals are required.

E. Submit Contractor Qualifications (from the Quality Assurance portion of this Specification)

1. Installation Experience

2. Designer Certification

F. The Contractor shall submit, for review by the Professional, identification and data of specific materials and equipment to be incorporated in the project. Shop drawings, hydraulic calculations, catalog cuts, and associated materials shall be submitted as a complete, single package. This package shall include:

1. Hydrant Flow Test results. This Contractor shall coordinate water flow tests required by this Contract. The Professional shall be notified at least 5 working days prior to the water flow test. The results of the water flow test shall be submitted within 10 working days following the water flow test and prior to or in conjunction with the submission of shop drawings.

2. Product data. Identification of specific product data and equipment shall be submitted prior to or in conjunction with the submission of shop drawings. Should more than one item or a specific item with multiple options appear on a single cut sheet, the item or items shall be specifically indicated.

3. Complete shop drawings. Failure of the Contractor to submit complete shop drawing packages may result in delay in processing time or rejection of the submittal. All such delays to the job resulting from the Contractor's failure to submit complete shop drawings at one time will be the responsibility of the Contractor. The Shop drawing submittal shall be subdivided by drawing and clearly identify the Contract Specification Section or drawing referenced, identifying and highlighting each item to be reviewed.

4. Submit materials and information described in NFPA 13, NFPA 14, NFPA 20, NFPA 24, NFPA 25, NFPA 70 and NFPA 72.

5. Hydraulic calculations and piping drawings. All calculations and CAD drawings shall:
   a. Be prepared under the direct supervision of an individual having NICET Level III or IV certification or an individual having registration as a Professional Engineer. Preparation of hydraulic calculations and/or piping drawings by individuals who do not have said certification or who are not directly supervised by an individual with said certification is prohibited.
   b. Be prepared using a commercially available computer models such as HASS, HydraCALC, Sprinkler-CALC, Sigma or "THE".
   c. Be prepared using the same computer model. Hydraulic calculations and the model used shall be consistent throughout the project. Hydraulic calculations shall be neat and orderly (e.g. columns and rows line up accordingly on printouts).
   d. Have hydraulic reference points, provided in a systematic and consistent manner, clearly indicated on both the shop drawings and the hydraulic calculations.

6. Where sprinkler systems are submitted separately, a schematic drawing indicating locations of all nodes used in the hydraulic calculations shall be included with the submission. Common piping and nodes shall utilize that same nomenclature.

7. Where phasing of construction requires submission of portions of the system, all piping and equipment associated with any calculations must be provided with the submittal. Additionally, the phasing plan as it relates to the fire protection system installation shall be provided either diagrammatically or by narrative.

G. Where the Contractor must revise and resubmit, the revised submittal shall be accompanied by the written response to all previous submittal comments. Failure to provide written response to previous comments shall be cause for rejection of the submittal.

H. CAD layout drawings shall be submitted for the automatic sprinkler system. The layout drawings shall be prepared at a scale of not less than 1/8 inch = 1 foot, and drawings sheet size shall be either 24x36 or 30x42 inches. The layout drawings shall include all information identified in NFPA 13 to be indicated and:

1. All Room numbers shall be provided on the drawings.

2. Plan and Elevation views of the mechanical room showing the sprinkler riser, proposed piping, equipment pads, dimensions of openings in floors, roofs, and walls, and equipment to establish that all proposed equipment will fit within the allotted spaces with clearances for installation and maintenance.

3. Plan views, with elevation views where necessary for clarity, of all piping and distribution systems indicating locations of proposed piping, hangers, sprinklers, water flow switches, hose outlets, and penetrations to fire-rated or smoke enclosure walls.

4. Where trapeze hangers are to be used, provide all pertinent information for determining size of trapeze member.

5. The drawings shall show proposed details for attachment, anchoring, and hanging to structural framing of the building; vibration isolation units; foundation and support; location and size of sleeves and prepared openings for passage of pipes. If the Contractor deems departures from the Contract Drawings necessary, details of such departures, including changes in related portions of the project and the reasons therefore, shall be submitted with the drawings for review by the Professional. Allowed departures shall be made at no additional cost to the Owner.

6. The available water supply data for the sprinkler system design shall be provided on the drawing that indicates the location of the fire protection water service entrance. The data shall include: date and time of test, location (relative to building) of static pressure reading and location of residual pressure reading, along with the pressures and flows during the test. Further, the data for adjustments to the water supply data, including elevation changes and friction loss components, between the street and the building shall be noted. Provide a “schematic” for clarity if necessary.

7. Items on or projecting through the ceiling shall be coordinated with other items and shall be shown on the reflected ceiling plan shop drawings submitted for the Professional’s review. Such items shall follow the intent as shown on the contract documents reflected ceiling plan drawings and shall not be installed until reviewed by the Professional.

I. The Contractor shall forward to all AHJ’s, for their review and comment, a minimum of 3 sets of the shop drawings indicating the final sprinkler head layout with associated hydraulic calculations.

J. Fire Protection Equipment Electrical Data shall be submitted for review:

1. Prior to submitting data for equipment requiring electrical service, the Contractor shall verify that electrical characteristics of equipment submittals comply with electrical service provided for the specified items of equipment.

2. Upon receipt of reviewed submittals for equipment provided under this Division of this specification, the Contractor shall coordinate the electrical service requirements such as, motor horsepower and full load amps; electrical service characteristics such as voltage and phase; and number of services for each item of equipment requiring electrical connections with the electrical drawings and specifications. The Contractor shall furnish to the Professional and the Electrical Contractor a complete typewritten list of electrical requirements for each item of equipment to be installed.

K. Operation and Maintenance Manuals shall be provided and include system components, water flow test information, CAD as-built drawings, as-built hydraulic calculations, and test certifications as a minimum. See Operations and Maintenance section of this Specification.

L. All firestopping material and installation methods must be approved by the Professional.

M. Provide a Valve Chart.

N. Provide documentation of grooved coupling training.

O. The Fire Protection Contractor shall submit for review and approval to the Local AHJ, three (3) sets of shop drawings and hydraulic calculations indicating the sprinkler system layout including head locations. Submit drawings with the required application and fee.

1.6 QUALITY ASSURANCE

A. The fire protection equipment and installation shall conform to the full meaning and intent of the following codes and regulations:

1. Maryland Building Performance Standards
   a. 2015 IBC with Department of Housing and Community Development (DHCD) modifications (Ref: COMAR 05.02.07)
   b. The State of Maryland Fire Prevention Code incorporating NFPA 1 Fire Code 2012 and NFPA 101, Life Safety Code 2012 (COMAR 29.06.01) including State Fire Marshal modifications

2. Any local Baltimore City Codes, Amendments or Ordinances.

3. Local Water Authority Rules and Regulations

B. The fire protection and installation shall conform to the full meaning and intent of the following National Fire Protection Association (NFPA) codes and standards (IBC/IFC Referenced Edition if so designated, otherwise the latest edition):

1. NFPA 13, Standard for the Installation of Sprinkler Systems

2. NFPA 14, Standard for the Installation for Standpipes and Hose Systems

3. NFPA 20, Standard for the Installation of Centrifugal Fire Pumps

4. NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances

5. NFPA 25, Inspection, Testing, and Maintenance of Water-Based Fire Protection System

6. NFPA 70, National Electrical Code (NEC)

7. NFPA 72, National Fire Alarm Code

8. NFPA 101, Life Safety Code

9. NFPA 291, Recommended Practice for Fire Flow Testing and Marking of Hydrants

C. The fire protection equipment and installation shall conform to the full meaning and intent of the latest edition of the following agency standards:

1. UL Fire Protection Equipment Directory

2. Factory Mutual Approval Guide

3. Requirements of the Owner's Insurance Company

D. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by the AHJ.

E. Workmanship and Materials

1. The workmanship and materials covered by these specifications shall conform to all ordinances and regulations of the city, township, county, and/or other AHJ.

2. All products and materials utilized in the fire protection systems shall be listed for fire protection service by Underwriter's Laboratories (UL) and/or approved for fire protection service by Factory Mutual (FM).

F. Qualifications of Contractor

1. The Contractor for the fire protection system shall be qualified for the work specified herein and be regularly engaged in the installation of automatic sprinkler systems and equipment.

2. The Contractor shall have a minimum of three years experience in the installation of sprinkler systems. Documentation shall be submitted to show that the Contractor has provided similar systems to those specified herein. Documentation on at least 3 similar systems shall be provided including the system size and the name of a contact person at the facility.

3. Documentation shall be provided to show that all fire protection systems are designed by a regular full-time employee with a Level III or Level IV NICET (National Institute for Certification in Engineering Technologies) certification in automatic sprinkler system layout or a Registered Professional Engineer. If such a certified individual is not employed, adequate documentation shall be provided to show comparable training and experience of the designer. Additionally, provide documentation for the registered PE or NICET level person that will review and certify the design.

4. Welding:
   a. All welders employed for the work shall be qualified under the requirements of ANSI B31.1.0 Section 127.5.
   b. Evidence of welders' qualifications shall be submitted to the Professional before any welds are made.
   c. All welding shall be performed at the shop.

5. The proposed Contractor shall submit evidence of the above qualifications items to the Professional prior to proceeding with any work on this project. Contractors not meeting these requirements will not be permitted to perform work specified under this section, unless specifically authorized in writing by the Owner.

G. Qualifications of Manufacturer and Products

1. Pipe, valves, fittings, and appurtenances shall be manufactured in the United States.

2. Firms whose equipment and product name appear within the Underwriter Laboratory's "Fire Protection Equipment Directory" list of specialties and/or accessories and Factory Mutual's "Fire Protection Approval Guide".

3. All products/parts installed or furnished under this Contract shall be listed and approved for use by the Authorities and Agencies listed herein.

1.7 AS-BUILTS, OPERATION AND MAINTENANCE INSTRUCTIONS, TRAINING

A. Refer to any front end specifications for additional information and detail requirements.

B. Operation and Maintenance Manuals, with a Table of Contents, shall include:

1. Printed material relating to all the fire protection equipment.

2. All flow test information including date, time, location and pressure readings.

3. Contractor's Materials and Test Certificates as required by NFPA 13, completed and signed.

4. Completed and signed Contractor's Material and Test Certificate for Private Fire Service Mains, as required by NFPA 24, where outside underground water supply is installed under this project, either by the Contractor or by others.

5. Completed and approved as-built hydraulic calculations.

6. Provide a copy of the valve schedule.

7. As-built drawings. Provide drawings updated in CAD.

8. A synopsis of the requirements of NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

C. Provide a minimum of 4 copies of Operations and Maintenance Manuals.

D. A minimum of 2 hours of instruction/training shall be provided to Owner designated personnel.

1. Before final inspection at a time designated by the Professional, CM or Owner, provide a competent representative to instruct Owner's designated personnel in operation, adjustment, and maintenance of products, equipment, and systems under this Division of the specifications. For equipment requiring seasonal operation, perform instruction for other seasons within six months unless requested otherwise.

2. The information provided for the Operation and Maintenance Manuals shall be used as basis of instruction. Review contents of said manual with personnel in detail to explain all aspects of operation and maintenance.

3. Prepare and insert additional data in the Operation and Maintenance Manual when the need for such data becomes apparent during instruction.

1.8 RECORD DOCUMENTS

A. Refer to the front end specifications for additional information related to record documents and related submittals.

B. As-Built Documents - Upon completion of approvals, installation, testing, and acceptance thereof of each phase of construction, the Contractor shall provide to the Owner one complete set of reproducible drawings, one set of CAD/Electronic Drawings, and one set of corresponding hydraulic as-built calculations.

1.9 CONTRACT DRAWINGS

A. The drawings are diagrammatic and are indicative of the work to be performed and show general locations of main piping and equipment. However, it is not intended that they show every pipe, fitting, or apparatus required for a complete installation.

B. When sprinkler head locations are shown on the fire protection contract drawings or the Architectural reflected ceiling plans, they are also diagrammatic and are indicative of the work to be performed. Contractor is responsible for determining final locations in accordance with NFPA 13 and the reflected ceiling plans.

C. Where a specific pipe routing, equipment arrangement or pipe size is indicated, the Fire Protection contract drawings shall be followed as closely as circumstances will permit unless prior approval is granted by the Professional. The Contractor may improve upon equipment locations and pipe routings as required to facilitate the proper installation of the system.

D. The Contractor is responsible for the proper installation of all materials and equipment required for a complete installation within the intent and meaning of the Fire Protection Contract documents and NFPA 13.

E. The Contractor shall follow drawings and specifications in laying out work and check drawings of other disciplines relating to work to verify space conditions. The Contractor is responsible for field verification of all fire protection equipment and water service connections. Scaling drawings without field verification is not sufficient.

F. Equipment layout is based on one typical manufacturer's product. Where equipment selected by the Contractor for use on the job differs from the layout indicated on the Contract Drawings, the Contractor shall be responsible for coordinating space requirements and connection arrangements.

1.10 GUARANTY

A. The components of the fire protection systems shall be guaranteed for a period of one year from the date of acceptance thereof, either for beneficial use or final acceptance, whichever is earlier, against defective materials, design, and workmanship. Upon receipt of notice from the Professional, CM or Owner of failure of any part of the equipment during the guaranty period, the affected part or parts shall be replaced promptly. This includes all parts and labor for removing the defective part or parts and subsequently replacing and installing the new part or parts at the expense of the Contractor.

1.11 FIELD MEASUREMENTS

A. It is the Contractor's responsibility to verify the location of any and all underground utilities in the vicinity of the work contained herein including the location of the fire water service. When it has been indicated that these utilities are to remain in place, the Contractor shall provide adequate means of support and protection during excavation operations.

B. Before ordering any equipment and material, or performing any work, the Contractor shall verify all measurements and dimensions at the job site and shall be held responsible for the correctness of same.

C. No extra compensation will be allowed on account of difference between actual dimensions and measurements and those indicated on the drawings.

D. Any difference which may be found shall be submitted to the Professional for consideration before proceeding with the work.

1.12 LINES AND GRADES

A. The Contractor shall lay out his work, establishing heights and grades for all exterior and interior piping included in these specifications in strict accordance with the intent of the drawings, the physical conditions of the building and the finished site grades. The Contractor shall be responsible for the accuracy of such heights and grades and make sure that they meet all physical conditions of the building and the requirements of these specifications.

1.13 PROTECTION OF SERVICES AND EQUIPMENT

A. The Contractor, at his own expenses, shall repair, replace and maintain in service any utilities, facilities or services (underground, aboveground, interior or exterior) damaged, broken, or otherwise rendered inoperative during the course of construction due to activities on the part of the Contractor. The method used by the Contractor in repairing, replacing, or maintaining the services shall be approved by the Professional and Construction Manager.

B. The Contractor shall protect, at his own expense, all materials or equipment related to his work that is liable to damage during the construction period. All openings into any piping, ducts, equipment, or building components, must be securely covered, or otherwise protected, to prevent injury, due to accidental encroachment of, or carelessly or maliciously dropped tools, materials, dirt, or any foreign matter. The Contractor shall be held responsible for all damage so done until his work is fully and finally accepted.

C. It shall be the responsibility of the Contractor to protect motors, pumps, electrical equipment, and all similar items of equipment from dirt, grime, plaster, water, etc. during all phases of construction. This protection shall be provided by covering equipment with transparent plastic sheeting to the satisfaction of the Professional or Construction Manager.

1.14 INTERRUPTION OF SERVICES

A. The Contractor shall schedule his work to avoid any major interruption of any utility services.

B. The Contractor shall not interrupt existing utilities serving facilities occupied and used by Owner or others during occupied hours except when such interruptions have been authorized in writing by Owner, Construction Manager or Professional and then interruptions shall occur only after acceptable temporary utility services have been provided. The Contractor shall provide a minimum of 10 working days notice to Professional, Owner and Construction Manager and receive written notice to proceed before interrupting any utility.

1.15 EQUIPMENT STORAGE AND EQUIPMENT HANDLING

A. Deliver and store equipment in the original manufacturer’s shipping containers.

B. Piping and other supplies that are not provided in original manufacturer’s shipping containers shall be stored in a neat and orderly manner that minimizes the potential for damage.

C. Protect pipe, fittings, and other fire protection equipment from the weather so as to avoid undo rust. Any component exhibiting rust shall be replaced at the discretion of the Professional, CM or Owner at no additional cost.

1.16 COORDINATION

A. The Contractor shall participate in the development of inter-trade coordination drawings.

B. The Contractor must coordinate his work with that of the other Contractors so that the work of all trades will be performed in an orderly manner and with the least possible interference. In the case where interference with the work of other Contractors should occur, the decision of the Professional or Construction Manager as to changes to be made in the work shall be final.

C. The Contractor must thoroughly familiarize himself with all specifications and drawings for the project so that he clearly understands his responsibility in relationship to the work to be performed under this Contract. The Contractor must plan and perform his work so as to permit the use of the building at the earliest possible date.

D. The Contractor shall be responsible for coordinating all fire protection equipment locations with the locations of all lighting fixtures, HVAC diffusers, ceiling architectural features, and structural members. The Contractor is responsible for coordinating the locations of all fire protection piping and equipment with the General Contractor and all other trades to prevent obstructions to the required sprinkler discharge pattern.

E. The Contractor is responsible for coordinating locations of all fire protection piping with respect to electrical equipment and the NEC. Routing of piping directly above electrical equipment shall be avoided.

F. The Contractor shall coordinate locations of fire protection system piping with respect to fresh air intake louvers. Routing of piping directly in front of such louvers shall be avoided due to potential freezing conditions. Refer to mechanical drawings for exact locations for all louvers. All louvers shall be shown on the shop drawing submittals.

1.17 CUTTING, PATCHING, AND FINISHING

A. Unless otherwise noted, the Contractor shall cut, patch and finish all penetrations and openings in walls, and floor/ceiling assemblies required for the installation of work to be performed under this Contract in accordance with this section of the specification and any additional front end specification requirements. All patching and finishing shall match existing adjacent undisturbed surfaces.

B. Penetrations made in existing or new fire rated chases, partitions, floors, etc. shall be sealed with an approved material and method as required to maintain the integrity of the fire separation in accordance with a UL method as well as any additional requirements herein.

C. Cutting of the construction excessively or carelessly done shall be repaired to match the original work by the Contractor and to the satisfaction of the Professional, Owner, and Construction Manager who will make the final decision with respect to excessive or careless cutting work. The Contractor shall seal all openings made in plenum spaces, fire rated floors, ceilings or partitions after all work has been installed. The material used for sealing the openings shall have a fire rating equal to or greater than the rating of the floor, ceiling or partition material.

D. Where present equipment is removed and unused opening remain in walls, floors, partitions, etc., the Contractor shall properly patch all such openings except as hereinafter specified under “Work by Others”. All patching and repairing shall be done by workmen skilled in this type of work and shall match present or new finishes.

E. No cutting shall be done which may affect the building structurally or architecturally without first securing the approval of the Professional. Cutting shall be accomplished in such a manner as not to cause damage to the building or leave unsightly surfaces that cannot be concealed by plates, escutcheons or other construction. Cutting shall not cause damage to the building or leave unsightly surfaces. Where such unsightly conditions are caused, the Contractor shall be required, at his own expense, to repair the damaged areas.

F. No structural member shall be cut without approval.

G. The Contractor shall contact the holder of the guarantee and obtain written approval before cutting the roofing membrane so as not to void said guarantee.

H. The Contractor shall set all sleeves, hangers, and anchors required for the work under this Contract and shall be responsible for their proper and permanent location.

1.18 PAINTING AND INDICATON

A. Painting

1. Steel equipment hangars, supports, and pipe shall be prepared as indicated below.

2. The Painting Contractor shall paint exposed sprinkler piping in all finished areas of the building including stairwells. The Contractor is responsible for preparing pipe surface to accept primer and paint to the satisfaction of the Painting Contractor. All surfaces shall be thoroughly cleaned of rust, scale, dirt, grease, dust, and like items, and sanded so as to provide a bond for new paint.

3. The contractor shall paint all piping within the Fire Pump Room. The color shall be red.

4. Shop paint all pipe with a powder coating application. If conventional painting is provided in lieu of powder coating apply at least 1 coat of approved primer and 2 coats of machinery enamel on all piping.

5. All painting shall conform to the manufacturer's requirements as well as any additional front end painting specification.

6. All painting shall be done in a careful, neat and workmanlike manner, with particular care being exercised to protect building equipment and finishes.

7. Provisions shall be made to protect sprinklers from being painted. All sprinklers having "non-factory-applied paint" on them shall be replaced.

8. The manufacturer shall paint all items of equipment. All equipment manufacturers shall supply sufficient paint to completely paint each unit one coat in the field to cover all scratches, etc., due to installation. The Professional will carefully inspect all equipment for acceptance. If paintwork does not meet the Professional's approval, the Contractor shall repaint all equipment found to be defective as directed by the Professional.

9. All exposed hangers and supports shall be primed and finished with rust inhibitor paint.

10. All nameplates and data plates that indicate or identify data on equipment shall not be painted, but shall be carefully marked and left unpainted.

11. Where pipe support members are welded to the structural building framing, scrape and/or brush clean and apply one coat of zinc primer to welding.

12. All colors to be used shall be submitted to the Professional for approval.

B. Identification

1. The Contractor shall provide permanently affixed identification of fire protection piping. This may include stenciled painting or labels.

2. Identify all sprinkler piping (except branch lines), concealed or exposed, with permanently affixed identification. Install in clear view and align with axis of piping. Locate identification not to exceed 15-feet on straight runs including risers and drops, adjacent to each valves and "T", at each side of penetration of structure or enclosure, and at each obstruction.

3. Identify service as "FIRE PROTECTION" and mark the direction of flow. Letters shall be of height equal to the diameter of the pipe on piping up to and including 1½ inches, and 2 inches high on pipes 2 inches in diameter and over. Flow arrows shall be approximately 4 inches long having a 1 inch wide head and base with a ½ inch wide shaft.

4. The band color shall be red and letter color shall be white.

5. Background color coding and stenciling for piping, equipment, and related appurtenances provided under this Contract shall meet the minimum standards for identification as set forth by the latest edition of the ANSI A13.1.

C. Contractor Indications

1. Clearly marked permanent labels which are securely fastened to the ceiling shall be provided to identify access points for concealed control valves in accordance with NFPA 13.

2. Place tags on all valves indicating function.

3. The following schedules shall be used for manufacture and application of indication:
   a. Plastic Nameplates: Laminated 3 layer plastic with engraved white letters on red background color.
   b. Metal Tags: Brass with stamped letters; tag size minimum 1 1/2 inch diameter with smooth edges.

1.19 EXCAVATION, BACKFILLING, AND COMPACTION

A. General

1. This section is applicable to all underground fire protection lines.

2. The Contractor shall notify the CM prior to commencing any excavation.

3. The Contractor shall perform all excavation, backfilling, compaction, and necessary finishing for all lines, equipment, and accessories installed under this Contract. Piping installation and testing shall be in accordance with NFPA 24 and applicable State and Local codes.

4. The Contractor shall provide all bracing, sheathing, and shoring necessary to perform and protect the excavations. Safety rails, lights, signs, etc. shall be provided as necessary or required for safety, as directed by the CM or as required to conform to governing laws.

5. The Contractor shall furnish, maintain, and operate pumping equipment of sufficient capacity to insure that all excavations and trenches required herein are kept free of water at all times.

6. All surfaces of streets, walkways, seeded areas, or finished grade areas disturbed by the excavation shall be restored to their original condition and/or as shown on the Civil site plans and specifications.

7. Existing structures, utilities, sidewalks, pavements, and other facilities not indicated for removal shall be protected from damage caused by settlement, lateral movement, undermining, washout, and/or hazards resulting from the excavation operations specified herein.

8. If it becomes necessary to install any lines or equipment in locations other than those shown, the CM's acceptance shall be obtained before starting said excavation.

9. The presence of explosives on the project site or the use of explosives in the execution of the work under this Contract is not permitted.

B. Excavation

1. All fire protection excavation is unclassified.

2. Trenches shall be dug to uniform width not less than 12 inches or more than 16 inches wider than the bell diameter. Trench sides shall be vertical. Excavate trenches to depth indicated or required. Carry depth of trenches for piping as required to establish desired flow line and invert elevations. Beyond building perimeter, keep bottom of trenches sufficiently below finished grade to protect against frost and allow for the minimum required depth of cover. The bottom of trenches shall be accurately graded to provide uniform and smooth flow throughout. Any over-excavation shall be backfilled with modified aggregate and thoroughly tamped.

3. If trench excavation operations are performed when the atmospheric temperature is less than 35 degrees Fahrenheit, the Contractor shall provide, at his own expense, cold weather protection to protect excavated trench bottoms from freezing. Under no circumstances will any pipe be permitted to be laid in a trench containing water or on a subgrade containing frost.

4. All material excavated shall be deposited on the side of the trenches and beyond the reach of sides. Excavated material shall not be piled where it will interfere with traffic.

5. Surplus excavated material not required for backfill shall be removed from the building site or distributed on the premises as directed by the CM.

6. Take up and re-lay pipe that is not laid true to required alignment or grade. Pipe that has had the joints disturbed after being laid shall be taken up and laid again. Deviation from the required lines and grades will not be permitted unless approved by the CM.

7. Pipe Embedding Material – All pipe shall be laid on a First Class granular bedding. The bedding shall be a minimum depth of 6 inches or 1/4 the pipe diameter, whichever is greater. The bedding shall provide uniform longitudinal support to the pipe and shall be

laid to provide the grade and line as shown on the drawing or as directed by the Professional. Compaction of bedding materials under the hunches and around the springline of the pipe shall be by hand tamping. Final bedding material for ferrous pipe materials shall extend from the springline of the pipe to a depth of 6 inches (minimum) above the top of the pipe.

C. Backfilling

1. Backfilling shall not be undertaken until all test and inspections have been completed.

2. Backfilling operations shall avoid damaging or displacing installed piping systems.

3. Contractor shall restore the surface of all excavations to their original conditions, including paved or unpaved streets, gutters, shrubbery, fences, walls, sidewalks, and sod. Contractor shall furnish all labor and material required.

4. All backfill material shall be free from cinders, ashes, refuse, vegetable or organic material, boulders, rocks or stones, frozen soil, or other material that is unsuitable. When the type of backfill material is not indicated on the plans or is not specified, the excavated material may be used, provided that such material consists of loam, clay, sand, gravel, or other material that is suitable for backfilling. Above the top of the pipe to the subgrade of the pavement, material containing stones greater than 6 inches in their greatest dimension may not be used.

5. All trench backfill shall be brought to subgrade ready for base material or topsoil. After the initial aggregate backfill layer has been placed, refill remainder of the trench using backfill materials specified below.

6. Walks and Parking Areas – Clean earth backfill compacted in 6 inch layers to a point 8 inches below the adjacent existing surfaces. Refill the remaining 8 inches with compacted and replace walk or paving as required.

7. Paved Areas - The Contractor shall comply with applicable regulations of Township, Borough, and City.

D. Compaction

1. Thoroughly compact subgrade prior to the installation of 6 inches of First Class pipe bedding. Following satisfactory pipe laying and in-line structure installation, backfill trenches to a height of at lease 12 inches above the top of the outside barrel of the pipe with No. 1B Crushed Stone.

2. All fill shall be compacted to 95 percent. Each layer shall be compacted to the specified percent of maximum density obtained at optimum moisture content, in accordance with ASTM D1557, method D and ASTM D1556 sand cone method.

3. Compaction shall be accomplished by approved equipment suited to the soil being compacted. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

4. Thoroughly compact successive layers of backfill material with a vibrating compactor of a type and size satisfactory to the CM. Compacting of this backfill by pudding or jetting will not be permitted. Use mechanical tampers to compact backfill materials in trench refill operations to produce a density of backfill at the bottom of each layer of not less than 95 percent of the maximum density obtained at optimum moisture content as determined by AASHTO T99 when requested by the CM. Perform field determinations of backfill density in accordance with AASHTO T 191.

5. The use of special equipment such as the "HYDRA-HAMMER" for compaction of backfill is prohibited.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Pipe and fitting shall be as specified herein and used on the services indicated. Pipe shall be clear and free of dirt, debris, or any other obstruction.

B. "Plain-end" pipe/fittings and threadable light-wall pipe are NOT permitted. All pipe must have a Corrosion Resistance Ratio ≥ 1.00 for the joint specified.

C. All sprinkler piping shall be steel. Additionally, all pipe and fittings shall be in accordance with the requirements of NFPA 13. All piping and fittings for the dry pipe system shall be galvanized. All piping and fittings for the wet pipe system shall be black. All piping which utilizes threaded fittings shall be Schedule 40.

D. Sprinkler piping 1-1/4 inches in diameter or larger, connected by welded flanged fittings or roll grooved fittings, shall be Schedule 40, Schedule 30, or Schedule 10 as permitted by NFPA 13. Cut grooves are not permitted. All sprinkler piping 2 inches in diameter and smaller (that is not roll grooved or welded) shall be Schedule 40 utilizing screwed fittings (plain end fittings shall not be accepted).

E. All miscellaneous drain and test piping and fittings shall be Schedule 40 internally and externally galvanized.

F. All above ground piping on the supply side of the backflow prevention device/fire pump shall be listed for potable service and in accordance with the local water department requirements and internally and externally galvanized steel pipe.

G. Outside underground piping shall be Class 52, cement-lined ductile-iron pipe listed for potable service and shall be in accordance with NFPA 24. HDPE piping, listed for fire water service applications, may be utilized.

2.2 VALVES – GENERAL

A. All valves in each system, except for special types, shall be the product of a single manufacturer. Valves shall have the name or trademark of the manufacturer and the working pressure stamped or cast on the valve body.

B. All valves requiring packing shall be designed and constructed such that they can be repacked under pressure.

C. Handwheels for valves 2 inches and smaller shall be malleable iron or aluminum except where specified otherwise. Handwheels for valves 2 ½ inches and larger shall be malleable or cast iron except where specified otherwise.

D. Valves shall have listing or approval agency identification mark stamped or cast on valve body. All valves shall be listed for fire protection service use.

E. All Fire Protection service valves shall be UL listed and FM approved, with minimum 175 psig (1200-kPa) non-shock working-pressure rating. Valves for grooved-end piping may be furnished with grooved ends instead of type ends specified.

2.3 GATE VALVES

A. All gate valves shall be in accordance with UL 262.

B. Gate valves (2 ½ inches in size and larger) shall be OS&Y type with iron body, bronze trim, solid wedge, and flanged ends.

C. Gate valves (2 inches in size and smaller) shall be OS&Y type with bronze body, solid wedge, and threaded end.

2.4 BUTTERFLY VALVES

A. Butterfly valves shall be lug type with ductile iron body, stainless steel stem, Buna N or EPDM seat, nickel or aluminum plated brass disc, and gear operator. Valve shall be listed for fire service and rated for the anticipated operating pressure.

B. Indicating Valves: NPS 2-1/2 and Smaller shall be in accordance with UL 1091 and be butterfly or ball-type utilizing a bronze body with threaded ends and integral indicating devices.

2.5 CHECK VALVES

A. All check valves shall be in accordance with UL 312.

B. Check valves (2 1/2 inches in size and larger) shall be Class 150, horizontal swing type with iron body, bronze trim, and flanged or grooved ends.

C. Check valves (2 inches in size and smaller) shall be Class 150, horizontal swing type with bronze body, composition disc, and threaded ends.

2.6 GLOBE AND ANGLE VALVES

A. Globe valves shall have bronze body, rising stem, composition disc, and be threaded.

B. Globe valves having cast iron handwheels shall be permitted.

C. Angle valves shall have bronze body, rising stem, composition disc, and threaded ends.

2.7 FLOW SWITCHES

A. Vane type waterflow switch/detectors shall be installed on the sprinkler system piping as designated on the drawings. Waterflow switches shall be furnished and installed by the Sprinkler System Contractor. Fire Alarm Contractor shall connect the flow switches to the Fire Alarm Control Panel. The two Contractors shall work in a coordinated basis to test the units.

1. Said switch/detectors shall be designed for mounting on either vertical or horizontal piping, but shall not be mounted in a fitting or within 12 inches of any fitting that changes the direction of water flow.

2. Said switch/detector shall have a sensitivity setting to signal any flow of water that equals or exceed the discharge from one sprinkler head for the specified retard period.

3. The waterflow switches shall have a minimum rated capacity of 15 amps at 125V AC and 2 amp at 0-30V DC resistive, two (2) normally open contacts, and shall be actuated by a polyethylene vane extending into the waterway of the piping.

4. The waterflow switch/detectors shall be of weatherproof, dust tight construction, shall provide a ½ inch conduit entrance, and shall be finished in red baked enamel.

5. The waterflow switch mechanisms shall incorporate an instantly recycling pneumatic retard element in the adjustable range of 0 to 70 seconds.

B. A pressure switch shall be provided on all Dry systems. Pressure type flow alarm switches shall contain one single pole, double throw contact (nominally rated at 2.5 amp at 30V DC). The unit shall be factory adjusted to operate on a pressure increase between 4 and 8 psi. They may be adjusted to operate on pressure between 4 and 20 psi.

2.8 VALVE SUPERVISORY SWITCHES/EQUIPMENT

A. Supervisory switches shall be installed on the system control valves. Supervisory switches shall be furnished and installed by the Sprinkler System Contractor. Fire Alarm Contractor shall connect the supervisory switches to the Fire Alarm Control Panel. The two Contractors shall work in a coordinated basis to test the units.

B. The mechanism shall be contained in a weatherproof, die cast aluminum housing, which shall provide a ¾ inch tapped conduit entrance and incorporate the necessary facilities for attachment to the valve.

C. Valve supervisory switches shall be designated for valve mounting either vertically or horizontally.

D. Dry pipe high low air pressure supervisory switches. Switches shall be provided with ½" NPT male pressure connection to be connected into the air supply line on the system side of any shutoff valve. Provide a bleeder valve in line with the switch as a means of testing the operation of the switch. The switch shall contain SPDT (Form C) switches. One switch shall operate at a pressure decrease of 10 psi from normal. The second switch shall operate at a pressure increase of 10 psi from normal. Switches shall be rated at 15.0 amps as 125/250 VAC and 2.5 amps at 30 VDC. The units shall have a maximum pressure rating of 250 psi and shall be adjustable from 10 to 175 psi. The switch housing shall be weatherproof and oil resistant. The cover shall incorporate tamper resistant screws. The unit shall be UL listed and FM approved.

2.9 IDENTIFICATION SIGNS

A. Identification signs shall be provided on all valves in accordance with NFPA 13.

B. Provide riser placards for each remote area of each system.

C. In addition to the required identification signs above, a means for identifying the locations of concealed control valves shall be provided with signage in the vicinity of each valve in a conspicuous location. The information provided on the identifying plate shall be as required by NFPA 13, including the location of the control valve, the area isolated by the valve, and the "normal" position of the valve, and shall be approved by the Fire Marshal's Office and the Professional prior to installation.

D. Signs shall be manufactured of metal or plastic, and shall be securely fastened.

E. A valve chart shall be provided to indicate the location of all valves with the function and areas served by said valves. The valve chart shall be accompanied by legible scaled plan views of the building indicating the relative location of all remotely located isolation valves and the bulk feed supply piping to said valves.

2.10 FLANGES

A. Flanges in threaded pipelines shall be cast iron screwed flanges.

B. Flanges in welded pipelines shall be steel weld neck or slip-on type welding flanges.

C. Flanges shall have either raised or flat faces. All flanges mating with adjacent flanges, valve fittings, and equipment shall be of the same type.

D. Flange gasket shall be 1/16 inch non-metallic, non-asbestos, ring type.

E. Flange bolts shall be carbon steel, all threaded type. Nuts shall be carbon steel hexagon type. Steel for bolt and nuts shall conform to NFPA 24 requirements.

2.11 GROOVED COUPLINGS

A. Grooved couplings shall be two-piece malleable iron or ductile iron, ASTM A536, with gasket and two bolts. Gasket shall be Buna N. Coupling shall be rated for 300 psig working pressure.

B. All mechanical fittings shall be manufactured by the same company.

C. Only full flow fittings shall be permitted.

D. Mechanical tees may be used to connect to 2 inch or larger pipe only. Mechanical tees, which incorporate a "U" bolt of hinged strap arrangement, shall not be used.

E. Fittings shall be roll grooved. Cut grooves are not permitted.

F. Flanged connection transitions shall be made via approved adapters.

G. The grooved coupling Manufacturer's Representative shall provide an on-site training session with the Contractor's sprinkler fitters to ensure that the products are being properly installed and utilized. The Contractor shall provide documentation of such training to the Professional.

2.12 HANGERS

A. All hanging methods shall be in accordance with the requirements contained in NFPA 13. The portion of the hanger that directly attaches to the piping or the building structure shall be listed for that purpose.

B. Fire Protection System piping shall not be supported from the bottom chord of bar joists.

C. Hangers used on sloped or angled structures shall be of the articulating beam clamp style. Do not bend or angle threaded rod.

D. The use of powder driven anchors for hanging of fire protection equipment is generally prohibited. The use of powder driven anchors may be permitted for certain applications where no other reasonable alternative exists. Specific approval by the Professional or CM is required prior to use.

END OF SECTION 21 05 00

SECTION 21 13 13 – AUTOMATIC SPRINKLER SYSTEM

PART 1 - GENERAL

1.1 STIPULATIONS

A. General provisions of the Contract Documents including General and Supplementary Conditions and Division 1 Specifications Sections apply to all work in this section.

B. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 WORK INCLUDED

A. This Specification applies to the installation of the automatic sprinkler system and manual standpipe system at Robert Poole Building #056.

B. Provide a new 6” inch Class 52, cement lined, ductile iron fire protection underground service line from 5-feet outside the building as shown on the drawings. The Contractor shall obtain the Flushing and Testing Certificate, as required by NFPA 24, from the contractor installing the outside underground prior to connection of sprinkler pipe. If this certificate cannot be obtained, the Contractor is responsible for flushing the outside underground.

C. Provide a double detector check type backflow preventer in the locations shown on the drawings for the fire protection service.

D. Provide and coordinate a confirming water flow test for the site in accordance with NFPA 291, prior to submitting all hydraulic calculations/shop drawings. Include test results with the submittal.

E. Design and install a hydraulically designed wet-pipe automatic sprinkler system throughout the entire building in accordance with NFPA 13, all referenced codes, and the requirements specified under “Sprinkler System Design” below. See Specification 21 05 00 Common Work Results for Fire Suppression for all applicable codes.

F. Design and install a hydraulically designed dry-pipe automatic sprinkler system throughout the attic of Building B in accordance with NFPA 13, all referenced codes, and the requirements specified under “Sprinkler System Design” below. See Specification 21 05 00 Common Work Results for Fire Suppression for all applicable codes

G. Provide a Class I standpipe system for Fire Department use in each stairwell and other locations as shown on the drawings. Each standpipe will have a 2 1/2 inch connection and a 2 1/2 inch by 1 1/2 inch reducer and cap. The system is to be installed per NFPA 14 requirements. Provide roof hydrants as required by the IBC.

H. Provide sprinkler protection as per NFPA 13 for any concealed combustible construction identified during the course of construction.

I. Provide dry pendent automatic sprinklers for use in cooler and freezer areas.

J. Provide dry sprinklers for use in areas subject to cold and freezing as required.

K. Provide all alarm and supervisory sprinkler system equipment (e.g., flow and tamper switches) for interface with the building fire alarm system. The Contractor shall coordinate these equipment locations with the Fire Alarm Contractor.

L. Provide a wall-mounted Siamese fire department connection as indicated on the drawings. Connection must be within 100 feet of hydrant when standpipe are provided.

M. Coordinate all equipment installations with the building architectural and structural features and with the other trades to ensure a complete, supervised, and operational system. Review architectural plans to understand any varying, sloped, and open ceilings, soffits, or bulkheads throughout the building.

N. The Contractor shall become knowledgeable of any phasing plan in place and bid the job accordingly.

1.3 SUBMITTALS

A. All submittals shall comply with any front end specification requirements as well as Section 21 05 00.

B. Product Data shall be submitted on the following items. Where more than one item, or a specific item with multiple options appear on a single cut sheet, the items shall be specifically indicated:

1. Waterflow Switches
2. Supervisory Switches
3. Sprinkler Heads, Cabinet, Escutcheons, and Guards
4. Fire Department Connection
5. Hose Valves
6. Valve Cabinets
7. Piping, Fittings, and Mechanical Couplings
8. Hangers and Supports
9. Test/Drain Assemblies
10. Control Valves

11. Alarm Check Valves

12. Dry Pipe Valve and Appurtenances

13. Backflow Prevention Device

14. Means of Identification of Piping and Valves

15. Means of Identification of Concealed Control Valve Locations

C. Operation and Maintenance Data shall be submitted on the following items:

1. Waterflow Switches

2. Supervisory Switches

3. Sprinkler Heads

4. Fire Department Connection

5. Test/Drain Assemblies

6. Control Valves

7. Alarm Check Valves

8. Dry Pipe Valve and Appurtenances

9. Backflow Prevention Device

10. Completed Final Certificates for All System Tests

D. Hydraulic Calculations

1. Data and all relevant drawings shall be submitted indicating hydraulic design calculations, flows, pressures, pipe sizes, and layout of all piping; including the outside underground to the effective point of available water supply data. Calculations and pipe layout shall also be submitted and approved by the AHJ. Provide any and all comments received from the AHJ and resolution thereof to the Professional for record.

2. Include the allowance for inside hose stream connections at the point of connection. Include the allowance for outside hose streams.

3. Hydraulic calculations shall be provided for the remote area of each specific hazard class (e.g., Light, Ordinary Group 1, and Ordinary Group 2).

4. Common piping throughout different sets of calculations shall utilize the same nomenclature.

E. Shop Drawings

1. CAD drawings shall be provided in accordance with the requirements of Section 21 05 00 and NFPA 13. Provide CAD working plan drawings and data as required by NFPA 13. The shop drawings, scaled at a minimum of 1/8 inch = 1 foot shall:
   a. Provide Room Names and/or Numbers along with the reflected ceiling layout, including light fixture locations, HVAC diffuser locations, and other ceiling mounted fixtures and devices to verify that the sprinkler system layout has been coordinated with the other trades.
   b. Provide the noded and dimensioned portion of the sprinkler system drawing independently of the reflected ceiling plan drawings (for clarity in submittal reviews).
   c. Provide ceiling elevations and pipe elevations.
   d. Indicate make, type, and orifice size of sprinkler heads.
   e. Identify all locations where piping and/or fittings will be exposed to sight along with identification of all trapped segments of pipe and auxiliary/low-point drains.
   f. Provide piping volume calculations for each Dry Pipe System.
   g. Identify all walls and/or floors which are fire-rated, smoke barriers, or smoke partitions that are penetrated by the fire protection piping or equipment. Identification of the wall/floor and penetration thereto shall include the required rating, type of construction, and reference to type of penetration seal that is to be used (including UL System Number). Refer to Architectural Drawings for locations.
   h. Include a diagram of all control valves, checks, drain pipes, and test pipes.
   i. Include a diagram of the underground water supply to the building. Include all piping between the building and the location of the confirming water flow test data. Identify source of water supply, pressure, and elevation.
   j. Provide a copy of the hydraulic design information sign that will be installed on the riser.

F. As-Builts

1. Prior to final acceptance, complete CAD as-built drawings and hydraulic calculations shall be submitted to the Professional for review. As-builts shall reflect all piping and head location deviations from the approved shop drawings including additional fittings.

2. Provide one half-sized, laminated set of approved as-built drawings. Install a complete set of these drawings at the sprinkler riser location.

3. Provide a copy of the revised hydraulic design information sign. Upon approval, install on the sprinkler riser.

4. Coordinate as-built submission with Section 21 05 00.

1.4 SPRINKLER SYSTEM DESIGN

A. The Fire Protection Contractor is responsible for a confirming water flow test in accordance with NFPA 291. The results shall be submitted in accordance with Specification 21 05 00. For bidding purposes, the water supply for the main along 36th Street is 57 psi static (at 0 gpm, hydrant at 36th Street and Sweet Air) and 10 psi residual at 1631 gpm (hydrant on 36th Street and Poole Street). The pressure hydrant location utilized in the calculations shall be the effective point of the flow test. The hydraulic calculations shall utilize either this water supply data or the "confirming" water flow test data, whichever is less at the sprinkler system demand flow rate.

B. De-rate the water supply by 10% of the static pressure reading at both the static and residual pressure values. For fire pumps, de-rate the city water supply by 10% and not the fire pump discharge.

C. Hydraulic calculations shall be done utilizing the Area/Density method outlined in NFPA 13 and shall entail all pertinent piping including all outside underground extending to the point of the aforementioned confirming water flow test data.

D. Hydraulic calculations shall not be done utilizing the Room Design Method provided in NFPA 13.

E. Dry Pipe and Double Interlock Preaction Systems shall be designed so as to limit the volume to under 750 gallons per system. If this volume limit cannot be met, the Contractor must design the system to trip within the 60 second limit in accordance with NFPA 13.

F. The hydraulic calculations shall use the following "C" values: Unlined Cast or Ductile Iron Pipe: C=80, Cement-Lined Cast or Ductile Iron Pipe: C=120, HDPE/PVC Underground Pipe: C=140, and Black Steel in Wet-Pipe Systems: C=110 and Galvanized Steel in Dry-Pipe or Preaction Systems: C=110.

G. The sprinkler system demand pressure shall be at least 5 psi less than the available pressure from the system adjusted from the effective point of the water flow test. With the fire pump included, it shall be measured at not more than 125 percent of the rated pump capacity.

H. The design area for all hydraulic calculations shall be a minimum of 1500 square feet for wet pipe systems and 1950 square feet for dry pipe systems, unless otherwise noted or required by NFPA 13, and represent the hydraulically most remote area. Sprinkler spacing and design density for all hydraulic calculations shall be as follows:

1. Where sprinkler head locations are not specifically shown, they shall be provided in accordance with NFPA 13 and these specifications to form a complete system.

2. Offices, Conference Rooms, Classrooms, Corridors, Concealed Spaces, Libraries, Auditoriums, and other areas of low combustible loading as defined by NFPA 13 shall have minimum design density of 0.10 gpm per square foot over the most hydraulically remote 1,500 ft^2.

3. Mechanical Spaces, Janitor's Closets, Cafeterias, Gymnasium, and other areas of moderate combustible loading as defined by NFPA 13 shall have minimum design density of 0.15 gpm per square foot over the most hydraulically remote 1,500 ft^2. Maximum sprinkler protection area will be limited to 130 ft^2.

4. Stages, Storage Rooms, Large Stack Room Libraries, Machine Shop areas, and other areas of moderate to high combustible loading as defined by NFPA 13 shall have a minimum design density of 0.20 gpm per square foot over the most hydraulically remote 1,500 ft^2. Maximum sprinkler protection area is limited to 130 ft^2.

I. The inside/outside hose stream demand shall be 100 or 250 gpm for light or ordinary hazard calculations respectively. The inside/outside hose stream demand shall be added to the hydraulic calculations in accordance with NFPA 13.

J. Hydraulic calculations shall be revised and resubmitted to include all system design modifications, at no additional cost to the owner, until a satisfactory design in accordance with these specifications is provided.

K. Piping for 2 1/2 inch hose connections shall be sized in accordance with NFPA 14.

L. All piping shall be concealed in areas with finished ceilings or chases unless otherwise indicated. Sidewall sprinkler heads in-lieu-of running exposed piping shall be utilized where possible. Where piping cannot be run concealed (e.g., areas without ceilings), the exposed piping shall be routed as inconspicuously as possible in a neat and orderly fashion.

M. The Contractor is responsible for the routing of sprinkler piping such that only piping serving the Electrical Rooms, Elevator Equipment Rooms/Shaft, Wiring Closets, and Telecommunication or data rooms shall be permitted to enter these rooms. Route piping so that it enters the room over the door. Routing of any piping above electrical equipment or panels shall be avoided throughout the building.

N. All sprinkler heads in areas throughout the building that are below 7 foot clearance or subject to mechanical damage shall be equipped with head guards.

O. Provide a supervised control valve on all sprinkler branch lines that protect the elevator shaft and equipment room as well as the areas for the main electrical service entrance and generator. The control valves shall be located outside of the equipment room or shaft enclosure.

P. Sprinklers shall be installed under all ducts or obstructions, greater than 48 inches in width, including overhead retractable doors, in accordance with NFPA 13.

Q. Sprinklers near heat sources shall be provided in accordance with NFPA 13, with respect to temperature rating and location.

R. Provide an inspectors test connection for each sprinkler system zone, as required. Test connections may be located off the system riser permitting that the initial system test can be conducted off the hydraulically most remote head. The most remote head should be an outlet with hose bib and cap.

S. All control, drain, and test connection valves shall be provided with permanently marked weatherproof metal or rigid plastic identification signs. The sign shall be secured with corrosion-resistant wire, chain, or other approved means.

T. Where zone control valves are concealed above ceilings, identification signs shall be provided in the vicinity of the control valve to indicate location of said valve, the area isolated by said valve, and normal position of said valve.

U. All drains and inspectors test connections shall be piped to the exterior or suitably sized drain risers as indicated on the drawings.

V. Auxiliary and low-point drains shall be kept to a minimum. Auxiliary drains shall be provided in accordance with NFPA 13 except that all trapped sections shall be provided with an auxiliary drain consisting of a valve 3/4" or larger and a plug or nipple and cap. Auxiliary and low-point drains that are required to be piped to an accessible location are permitted to discharge to the building exterior, drain risers, mop receptors/sinks, or floor drains. All pipe segments that trap more than one head shall contain a low-point drain.

W. All piping and fittings on the discharge side of all drain valves shall be internally and externally galvanized.

1.5 EXTRA STOCK

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 in accordance with NFPA 13, shall be finished, wall-mounted steel cabinets with a hinged cover and space for the minimum required spare sprinklers plus sprinkler wrench. Include a separate wrench for each type of sprinkler on Project.

2. Provide 3 spare sprinkler head guards for every 12 installed or portion thereof.

3. Locate extra stock near the sprinkler riser.

PART 2 - PRODUCTS

2.1 ALARM VALVES

A. A 6 inch alarm check valve shall be provided for the system.

B. Provide a full trim package including retard chamber.

2.2 DRY PIPE VALVES

A. A minimum 4 inch Dry Pipe Sprinkler valve shall be provided for each system. Valves shall be UL Listed.

B. Provide a full trim package. Provide an accelerator or other listed quick opening device on the system. Provide all pressure switches, flow switches, supervisory switches and low/high air pressure switches in accordance with NFPA and the manufacturer's recommendations.

C. Provision shall be made to prevent excessive water accumulation. The dry pipe valve shall be fitted with an alarm bypass test connection so the waterflow device may be tested without opening the dry pipe valve.

D. Provide a compressor rated for the capacity of the system that is capable of maintaining the required operating pressure on the dry system and capable of full recovery within 30 minutes. The compressor can be a riser mount or tank mounted as required. The Fire Protection Contractor shall provide the starter. The compressor shall have an electrical rating of 115 volts, single phase 208 volts three phase. Alternate voltages or phase arrangements shall be permitted if the compressor is compatible with the available electrical service (e.g. a 230 volt rated compressor may by capable of working on 208 volt service.

2.3 ELECTRIC ALARM BELL

A. Electric alarm bells shall be a nominal 8-inch diameter with a red powder coating finish. Bell shall have a typical decibel rating of 92 dB. The bell shall be rated for use at 24VDC and approved for outdoor use (-40°F to 150°F). The bell shall be UL Listed and FM Approved. Typical vendor and model is Potter Electric Signal Company model PBD248.

B. Provide a weatherproof backbox approved for outdoor use. Typical vendor and model is Potter Electric Signal Company model BBK-1.

2.4 SPRINKLER HEADS

A. All sprinkler heads shall be the product of a single manufacturer, UL listed, and FM approved. All heads shall be the same model year and style throughout. The Professional must approve any deviations.

B. Automatic sprinklers shall have a heat responsive element complying with UL 199

C. Sprinklers shall have an ordinary temperature rating unless otherwise required by NFPA 13. Sprinkler heads located in the elevator shafts and elevator equipment rooms shall have an intermediate temperature rating between 200 – 225 degrees F.

D. All areas shall be provided with quick response sprinkler heads, except for those in the elevator shafts and elevator equipment rooms which shall be standard response heads.

E. Upright or pendent type sprinkler heads having a brass finish shall be utilized in all areas without finished ceilings.

F. Dry-pendent or dry-horizontal type sprinkler heads shall be provided for areas subject to freezing such as, coolers and freezers or loading docks. Also, utilize listed dry sprinklers where pendent sprinklers are required on Dry Pipe Systems. Do not install wet-type sprinklers in these areas.

G. Concealed sprinkler head with cover plates having a white factory applied finish, shall be utilized in all areas having finished ceilings.

H. Provisions for factory custom colored sprinkler heads or cover plates. Base bid shall include one custom color. Verify color selection and location with the Architect prior to ordering.

I. Extended coverage heads are permitted. If utilized, the specific requirements of the manufacturer's listing and NFPA 13 shall apply.

J. Sprinkler head guards shall be wire-cage type and include a fastening device for attaching to sprinkler. They shall be oriented to provide the maximum accessibility for operation. Pendent heads with guards or concealed type sprinklers may be utilized in lieu of recessed heads to comply with this requirement.

2.5 SPECIALTY SPRINKLER FITTINGS

A. Specialty Fittings shall be UL listed and FM approved. They shall be made of steel, ductile iron, or other materials compatible with piping.

B. Mechanical T Fittings shall comply with UL 213 and have a ductile iron housing with pressure responsive gaskets, bolts, and threaded or locking-lug outlet.

C. Mechanical-Cross Fittings shall comply with UL 213 and have a ductile iron housing with pressure responsive gaskets, bolts, and threaded or locking-lug outlets.

D. Drop-Nipple Fittings shall comply with UL 1474 and have a threaded inlet, threaded outlet, and seals that are adjustable.

E. Sprinkler Drain and Alarm Test Fittings shall be UL listed and utilize a cast or ductile iron body. They shall have a threaded inlet and outlet, a test valve, and orifice and sight glass.

F. Sprinkler Branch-Line Test Fittings shall be UL listed and have a brass body with threaded inlet and capped drain outlet and threaded outlet for sprinkler.

G. Sprinkler Inspector's Test Fittings shall be UL listed utilizing a cast or ductile iron housing. They shall have a threaded inlet, drain outlet, and sight glass.

2.6 ESCUTCHEON PLATES

A. Provide escutcheons for all exposed pipes passing through walls, partitions, or ceiling. Escutcheons shall be steel, primed and finish painted to match adjacent wall finish.

2.7 BACKFLOW PREVENTION ASSEMBLIES

A. The backflow prevention device shall be a minimum 6 inch Double Check Detector type backflow prevention assembly. Backflow prevention assemblies shall be UL listed for fire protection service, listed for use in the vertical orientation (if so installed), and in accordance with the AHJ requirements.

2.8 FIRE DEPARTMENT CONNECTION (FDC)

A. The FDC shall be brass wall mounted siamese type, with four 2 1/2 inch inlets by 6 inches, single clapper with female thread connections matching local Fire Department specifications, 2 1/2 inch caps/plugs, finish to match FDC and chains. For standpipes, provide a 2 ½ inch connection for each 250 GPM of standpipe demand.

B. The FDC shall be equipped with an exterior wall plate labeled "AUTO SPKR STANDPIPE" and check valve with ball drip arranged to maintain the FDC in a dry state. All exposed surfaces shall be finished to match the FDC.

2.9 STANDPIPE HOSE VALVES

A. The hose valve cabinets shall be equipped with a 2 ½-inch chrome angle valve with matching 2 ½-inch by 1 ½-inch adapter and 1 ½-inch cap.

B. The hose outlet threads shall match the Fire Department specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installation shall comply with all applicable codes and standards.

B. The drawings show the riser locations and general routings for the mains. The riser locations shall be adhered to as closely as possible. The indicated locations for the mains are based on proposed routings of equipment by other trades and structural elements. The contactor is responsible for providing coordination drawings to the Professional reflecting the other trades works prior to installation.

C. The drawings may show proposed head locations (dots). The contractor shall determine final head locations in accordance with NFPA and in coordination with the reflected ceiling plan. Any heads shown are not intended to show all actual locations or be representative of the total device count. Any heads shown on the fire protections drawings or reflected ceiling plans are to show the intent only.

1. Sprinkler heads shall be located as required and coordinated with the Reflected Ceiling Plans. Deviations from submitted locations shall be approved by the Professional prior to installation.

2. Sprinkler heads shall be installed in a symmetrical and orderly fashion.

3. Sprinkler heads in suspended acoustical tile ceiling shall be located in center of ceiling tile. Where the ceiling tile is scored, creating multiple surfaces, the location of the sprinkler head shall be with respect to the surface.

4. All recessed sprinkler heads shall be fully recessed. A maximum tolerance of +/- 1/4-inch between any recessed sprinkler heads within a room or common visual area shall be accepted.

5. Positioning of sprinkler heads with respect to obstructions located below or adjacent to the sprinkler heads shall be evaluated in accordance with the requirements of NFPA 13.

6. Sprinkler heads in storage areas, janitor's closets, and like areas shall not be located within 3 feet of the walls. If this minimum dimension cannot be met due to the room dimension or ceiling coordination features, the head shall be placed in the best alternate location.

7. Sprinkler heads shall be provided in the elevator pit in accordance with NFPA 13.

8. Sprinkler heads shall be kept free of dirt and debris at the time of installation by covering with plastic bags or covers. Removal of the bags shall be the responsibility of the contractor.

9. Remove and replace heads having paint other than factory finish.

D. The contractor may utilize tree, loop, grid type, or combination thereof piping systems as necessary for the wet pipe system. Dry Pipe and Double Interlock Preaction Systems shall not be gridded.

E. Concealed combustible construction should not be anticipated by the contractor during the development of their bid and subsequent design. If identified by the contractor during the course of the project, it shall be brought to the Professional's attention.

F. Coordinate the work of this section with the related work specified under other sections and all Electrical Equipment locations.

G. Piping shall be pitched to permit draining of the sprinkler systems. Drain valves shall be installed at low points in accordance with NFPA 13, except that all drains shall have a 3/4 inch valve and cap or plug and nipple as a minimum.

H. The installation shall not add heads or institute pipe changes in direction or size without submitting revised calculations.

I. All piping in areas with finished ceilings shall be concealed.

J. Locate pipe runs to minimize obstructions of other work and to avoid obvious conflicts.

K. Piping shall be routed in an orderly manner, plumb and parallel to the building structure. Pendent sprinkler "drops" shall be vertical to the ceiling. Piping shall be installed to conserve building space, and in such a manner that it does not interfere with the use of space, other work, or the required headroom.

L. Where trapeze hangers are used, documentation shall be provided to the Professional for each such hanger indicating location, size, length, type, and all pertinent information for reviewing against the requirements of NFPA 13.

M. Changes in direction of piping shall be made with fittings.

N. "Tee" fittings with plugs shall not be used as a substitute for "Elbow" fittings unless approved by the professional prior to installation.

O. Pipe size transitions shall be made with reducing fittings. Bushings shall not be used.

P. Any sprinkler pipe, which passes through an exterior wall, shall be internally and externally galvanized.

1. Do not use welded joints with galvanized steel pipe.

2. Flanges, unions, and transition and special fittings with pressure ratings the same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise noted on the drawings.

Q. The contractor is ultimately responsible for:

1. Maintaining all components of the fire protection system free and clear of all dirt, debris, or other potential obstructions.

2. Not storing materials directly on the ground.

3. Making sure that the open ends of piping are plugged or capped during the construction to prevent dirt or debris from entering the pipe where pipes, fittings, and equipment are located in areas subject to dirt or debris.

4. Using methods that prevent damage, deterioration, and other loss during shipping and on-site storage. These include: using padded or strap slings, etc. as appropriate for materials being handled, lifting equipment by lift points provided or recommended by the manufacturer, and storing equipment away from the effects of rain, wind-driven dust, and other similar phenomena.

R. Extended coverage sprinklers may be used, except for mechanical rooms or other potentially obstructed areas.

S. Test connections shall not discharge to the interior of the building.

T. All piping on the discharge side of drain valves shall be internally and externally galvanized.

U. Electric Alarm Bell. An electric alarm bell shall be provided for the sprinkler systems. A common bell can be utilized for all valves within the same room.

V. Provide a concrete splash block on grade for all exterior sprinkler/standpipe drains.

3.2 PENETRATIONS

A. All penetrations shall be completed in a neat and orderly fashion.

B. Penetrations of fire-rated wall and/or floor assemblies shall be with a UL listed fire stopping assembly appropriate for the rating and configuration of the penetrated assembly. The number of penetrations shall be kept to a minimum. See the Architectural Drawings to verify floor or wall ratings.

C. Except where concrete walls/floors/partitions are core-drilled, provide pipe sleeves where piping passes entirely through walls, floors, and/or partitions. Secure sleeves to the wall, floor, and/or partition in position during construction in a permanent manner.

D. Provide sleeves of sufficient length to pass through entire thickness of walls, floors, and roofs.

E. Provide 1-inch minimum clearance between exterior of piping and interior of sleeve (i.e., 1-inch annular space). Firmly pack annular space with mineral wool insulation.

F. Seal space at both ends of the sleeve with plastic waterproof cement that will dry to a firm but pliable mass, or provide a mechanically adjustable segmented elastomeric material.

3.3 JOINTS

A. Threaded joints shall be made up with a mixture of graphite and oil applied to male threads only.

B. After cutting, but prior to threading, sprinkler piping shall be reamed and deburred. Additionally, the piping shall be “wiped” out with an absorbent cloth or rag following threading operations (and prior to installation of fittings to the pipe) for the purpose of cleaning and sopping up excess oil.

C. Welded joints for steel pipe shall be fusion welded in accordance with the American Standards Code for pressure pipe, ANSI B31.1, Section 6. All welding shall be performed at the shop.

D. Flanged joints shall be made with ring type non-metallic gaskets, bolts and nuts.

E. Outside Underground Piping:

1. All piping shall be installed per NFPA 24.

2. Tie Rod Anchors:
   a. Rod and clamp type anchors shall be installed on all hub and spigot joints in underground pipe including mechanical joint and push-on joints where change in direction of pipe run occurs unless UL listed or FM approved restrained joints are used. Straight runs of pipe do not require rod and clamps.
   b. After installation, rods and clamps shall be covered with coal tar coating.

3. Thrust Blocks:
   a. Concrete thrust blocks shall be installed at each change in pipe direction on underground piping and at each tee and dead end in accordance with NFPA 24.
   b. Restrained joints that are listed in the Factory Mutual Approval Guide may be used with ductile iron pipe instead of thrust blocks or tie rod anchors.

3.4 WATERFLOW SWITCHES

A. This Contractor shall provide all vane type waterflow switches under this Contract.

B. The Fire Alarm Contractor shall furnish and install all necessary wire, conduit, and boxes to properly connect flow switches to the fire alarm system.

C. This Contractor shall coordinate with the Fire Alarm Contractor to insure that the flow switches provided are compatible with the fire alarm system and meet the requirements of the NEC.

D. The waterflow switches shall be installed with the retard setting set to between 20 and 30 seconds.

E. The Contractor shall provide a dry pipe alarm pressure switch under this contract.

3.5 VALVE SUPERVISORY SWITCHES/EQUIPMENT

A. Valve position supervisory switches shall be installed on all control valves.

B. This Contractor shall provide all sprinkler valve supervisory switches under this Contract. The Contractor shall also verify the make and model of all valves to ensure that the switches provided are compatible.

C. The Fire Alarm Contractor shall provide all necessary wire, conduit, and boxes to properly connect supervisory switches to the fire alarm system.

D. This Contractor shall coordinate with the Fire Alarm Contractor to insure that the supervisory switches provided are compatible with the fire alarm system and meet the requirements of the NEC.

E. The Contractor shall provide the high/low air pressure switch for each dry pipe and preaction sprinkler system under this contract.

3.6 SPRINKLER GUARDS AND SHIELDS

A. Provide and install guards on sprinkler heads where heads are within 7 feet of the finished floor or wherever sprinklers may be subject to mechanical injury, such as small closets.

B. Provide and install guards on sprinkler heads located in rooms subject to activities with projectiles such as gymnasiums, auxiliary gyms, and exercise rooms.

C. Provide and install guards on sprinkler heads located at the base of the elevator shafts.

3.7 FIRE DEPARTMENT CONNECTION (FDC)

A. Locate the FDC such that sufficient clearance from all walls, obstructions, or other equipment is provided to allow full swing of the fire department wrench handle.

B. The FDC shall be mounted at least 18 inches above pavement, sidewalks or grade adjacent to the exterior of the building.

3.8 SPECIALTY SPRINKLER FITTING INSTALLATION

A. Install specialty sprinkler fittings according to manufacturer's written instructions.

3.9 VALVE INSTALLATION

A. Refer to Division 15 for installing general-duty valves. Install fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13, manufacturer's written instructions, and the AHJ.

B. Gate Valves: Install fire-protection-service valves supervised-open, located to control sources of water supply except from fire department connections. Provide permanent identification signs indicating portion of system controlled by each valve.

C. Alarm Check Valves: Install valves in vertical position for proper direction of flow, including bypass check valve and retard chamber drain-line connection.

D. All valves installed in horizontal lines shall be installed with the stems horizontal or above. Valve handwheels shall be oriented, when installed, to provide maximum accessibility for operation.

E. Dry Preaction System Valves: Install as per the manufacturer's instructions and in compliance with NFPA 13.

F. Prepare the air compressor for connection to the system and for wiring by others.

G. Prepare the air compressor for connection to the electrical power system. Provide connection of monitoring devices, including the low-pressure alarm to the fire alarm system. Air compressors of differing voltages or phase may be available from the manufacturer. The ability to utilize a compressor of differing electrical characteristics to that specified is solely based on coordination with the electrical contractor and the availability of service. The Contractor shall be responsible for all changes required by the Electrical Contractor.

3.10 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements of NFPA 13 and Specification 21 05 00.

3.11 COMMISSIONING

A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.

B. Verify that air compressors and their accessories are installed and operate correctly.

C. Verify that specified tests of piping are complete.

D. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.

E. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.

F. Verify that interconnected potable-water supplies, where permitted, have correct types of backflow prevention installed.

G. Drain dry-pipe sprinkler piping.

H. Pressurize and check dry-pipe sprinkler piping air-pressure maintenance devices and air compressors.

I. Fill wet-pipe sprinkler piping with water.

J. Energize circuits to electrical equipment and devices.

K. Start and run air compressors.

L. Adjust operating controls and pressure settings.

M. Coordinate with fire alarm tests. Operate as required.

3.12 DEMONSTRATION

A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.

B. Schedule demonstration with Owner. Allow at least 7 days advance notice.

3.13 TESTING

A. The contractor shall notify the Professional and the AHJ 3 weeks or more in advance of all tests to be conducted.

B. All underground piping shall be flushed prior to connection to system risers in accordance with NFPA 24 and documented as such.

C. The entire system, including the outside underground, shall be tested in accordance with the requirements of NFPA 13, NFPA 24, and all local requirements. Contractor's Material and Test Certificates shall be completed, signed, and dated and included in the Operations and Maintenance Manuals. The Contractor is responsible for obtaining copies of the Contractor's Material and Test Certificates for the Underground installed by the Civil contractor. If such a certificate cannot be obtained, the contractor shall be responsible for performing the test and preparing the certificate.

D. Any retesting that is required due to failure of any test for any reason shall be conducted at no additional cost to the owner. Any corrections or repairs to the system or building necessary due to such a failure, and retesting of the system shall be performed at no cost to the owner.

E. Report test results promptly and in writing to the Professional and AHJ.

END OF SECTION 21 13 13

SECTION 21 30 00 – FIRE PUMPS

PART 1 - GENERAL

1.1 STIPULATIONS

A. General provisions of the Contract Documents including General and Supplementary Conditions and Division 1 Specifications Sections apply to all work in this section.

B. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 WORK INCLUDED

A. Provide and install a fire protection pumping system for the building which includes the following:

1. Electric fire pump and jockey pump

2. Fire pump controller with automatic transfer switch and jockey pump controller

3. All associated mounting pads for fire pump and jockey pump

4. Test header and associated piping and fittings

B. Interface the fire pump controllers with the building fire alarm system

1.3 SUBMITTALS

A. General: All submittals shall comply with the requirements of any front end specifications, Section 15300 - Basic Fire Suppression Materials and Methods 21 05 00 Common Work Results for Fire Suppression and the following:

B. Product Data shall be submitted for the following items:

1. Fire Pump

2. Jockey Pump

3. Fire Pump Controller

4. Jockey Pump Controller

5. Test Header and Valves

6. Piping and Fittings

C. Design Data shall be submitted for the following items:

1. Electrical Requirements

2. Start and Stop Pressure Settings

3. Pump Curves

D. Layout Drawings of the Fire Pump Room in Plan and Elevation Views.

E. Operation and Maintenance Instructions. Data shall be provided for the following items:

1. Fire Pump

2. Jockey Pump

3. Fire Pump Controller (Including “Start” and “Stop” Pressure Settings)

4. Jockey Pump Controller (Including “Start” and “Stop” Pressure Settings)

5. Test Header

6. Acceptance Test Reports

1.4 QUALITY ASSURANCE

A. Utilize the IBC/IFC referenced editions of the following National Fire Protection Association (NFPA) standards if so designated, otherwise use the latest edition.

1. NFPA 13: Standard for the Installation of Sprinkler Systems

2. NFPA 20: Standard for the Installation of Centrifugal Fire Pumps

3. NFPA 70: National Electrical Code

4. NFPA 72: National Fire Alarm Code

B. Qualifications of Manufacturers: Pipe, fittings, pumps and controllers shall be manufactured in the United States.

1.5 FIRE PUMPING SYSTEM DESIGN

A. The fire pump and associated equipment installation shall be in strict accordance with NFPA 20 and arranged as closely as possible as indicated on the Contract Drawings.

B. The fittings and couplings in the pumping system shall be rated for the anticipated system operating pressures.

C. The fire protection pumping system shall consist of the following components:

1. An electric-motor-driven fire pump
2. Electric-motor-driven jockey pump with all associated piping
3. A wye-delta type fire pump controller with automatic transfer switch for the electric-motor-driven fire pump
4. A pump controller for the electric-motor-driven jockey pump
5. Mounting pads for both jockey and fire pumps
6. Piping, valves and appurtenances
7. Tamper switches
8. A 3 port fire pump test header with valves
9. System bypass line

1.6 EXTRA STOCK

A. Provide 1 set of gaskets for each pump type and model on the system.

PART 2 - PRODUCTS

2.1 FIRE PUMP

A. Fire pump shall be single stage, vertical inline type with electric-motor drive. Pump and drive unit shall be Underwriter's Laboratory (UL) Listed for fire protection service and constructed in accordance with NFPA 20.

B. Preliminary sizing of the fire pump for bidding purposes shall be rated for 500 gpm at 45 psi. The electric-motor-driven fire pump shall be driven by an electric motor designed with a maximum rating of 20 HP, 3 phase, 60 cycle motor, 480 volt and design letter "B".

C. Pump shall be designed to deliver 150 percent of rated capacity at minimum of 65 percent of rated head.

D. Pump casing shall be cast iron with flanged suction and discharge connections. Flanges shall be equivalent to ANSI B16.1 flange ratings. Casing shall be split on the shaft centerline to allow access to rotating elements without disturbing drive alignment.

E. Casing and impeller wear rings shall have renewable bronze rings locked in position to prevent rotation.

F. Bearings shall be steel, grease lubricated and shall have a minimum B-10 life of 20,000 hours. The bearing housing shall be designed to flush lubricant through and provide continuous

cleaning of bearing surfaces. Bearings shall be removable without removing the rotating element or dismantling the pump.

G. Pump shaft shall be steel.

H. Shaft sleeves shall be renewable, bronze slip-fit over the shaft, shall extend full length through the seal box and shall be locked in place.

I. Impellers shall be enclosed bronze double suction type hydraulically and dynamically balanced.

J. Pump shaft seal shall be stuffing box design with split bronze glands.

K. Pump and motor base shall be formed steel or cast iron with drain pan base. The pump shall be connected to the driving electric-motor through a flexible coupling. Coupling shall have a formed sheet steel coupling guard bolted to the base plate.

L. Motor shall be open drip proof type with mounting base. Motors shall comply with NFPA 20.

M. Pump shall be fitted with the following accessories:

1. Automatic casing air relief vent.

2. Casing drain cocks.

3. Discharge pressure gauge (0-300 psig).

4. Suction pressure gauge (30 inches Hg to 80 psi).

5. Name plate with capacity, head, impeller diameter, speed, model number and serial number.

N. Fire pump shall be constructed to permit complete servicing without breaking the pipe or motor connections.

O. The fire pump shall be equipped with statically and dynamically balanced rotating parts.

P. A check valve shall be provided in the discharge line of the fire pump.

Q. A bypass line shall be provided for the fire pump which is equipped with OS and Y valves and a check valve.

R. OS and Y valves shall be provided on the supply and discharge lines of the fire pump and on the system side of the check valve to permit the pump and check valve to be isolated.

2.2 FIRE PUMP CONTROLLER

A. The fire pump shall be equipped with a fire pump controller and automatic transfer switch. The controller shall be completely assembled, wired and tested by the controller manufacturer prior to shipment from the factory and labeled “Fire Pump Controller”.

B. The controller shall be located as indicated on the drawings. The controller shall be so located or protected that it will not be injured by water escaping from the pump or connections.

C. Fire pump controller shall be wye delta, closed transition type assembled, wired and tested at the factory. Controllers shall be designed in accordance with NFPA 20 for fire pump service. Assembly shall be Listed UL for said use.

D. Controller cabinets shall be floor mounted type NEMA 12 formed steel construction with baked enamel finish. All internal components shall be accessible from the front.

E. Fire pump controller components shall be designed for short circuit capacity of 30,000 amperes at 480 volts.

F. Electric fire pump controller shall include alarm or supervisory features for remote monitoring via the fire alarm system. The controller shall provide all required visible lights on the controller panel and all contacts required to operate circuits such as connection to the alternate power source.

1. Alarm contacts for remote pump “running”.

2. Supervisory contacts for remote pump “loss of phase”.

3. Supervisory contacts for remote pump “phase reversal or failure”.

4. Supervisory contacts for “controller connected to alternate source”.

5. Contacts to operate circuits for fire pump running, loss of phase, and phase reversal when connected to the transfer switch.

6. Extra contacts to shed power loads from the generator when switched to the alternate power source.

2.3 JOCKEY PUMP

A. Furnish and install a jockey pump to operate at 3,500 RPM with a capacity of 5 gpm at a 50 psig boost. Unit shall be driven by a ½ HP, 480 volt, 3 phase 60 cycle motor.

B. Jockey pump shall be a centrifugal close-coupled, vertical type with electric motor mounted on common base. The pump shall be bronze-fitted construction with casing relief valve and equipped with a mechanical seal. “Turbine” type jockey pumps are not acceptable.

C. Motor shall be open drip-proof type with foot mounting base.

D. The jockey pump shall be equipped with shut-off valves and a check valve on the discharge side.

E. Pump casing shall be cast iron.

2.4 JOCKEY PUMP CONTROLLER

A. Controller shall be same manufacturer as fire pump controller.

B. Jockey pump controller shall be combined manual/automatic type assembled, wired and tested at the factory. Assembly shall be listed by UL for said use.

C. Controller cabinet shall be floor mounted NEMA 12 formed steel construction with baked enamel finish. All internal components shall be accessible from the front.

D. Controller shall include the following:

1. Provide 1 externally operated fusible disconnect switch.

2. Provide 1 across the line magnetic starter with thermal overload protection.

3. Provide 1 manual off automatic selector switch.

4. Provide 1 running period timer to keep motor running for a predetermined time after each automatic start.

5. 1 pressure regulator of the Bourbon Tube type with adjustable cut-in and cutout points that control the automatic operation of the motor.

2.5 VALVE SUPERVISORY SWITCHES

A. Supervisory switches shall be installed on each system shut-off valve in accordance with Section 15300 Section 21 05 00.

2.6 TEST HEADER

A. Test header shall be flush wall mounted, 3 port type with cast iron body, 2 1/2 inch straight bronze valves and valve caps with chain. All exposed surfaces of the test header shall be rough brass finished.

B. The header shall be mounted 24 inches above pavement, sidewalks or grade adjacent to the exterior of the building.

C. Coordinate final location prior to installation with respect to access and drainage.

D. The Fire Protection Contractor shall provide valves for each test outlet. The valves shall be located in a cabinet in the fire pump room. The test header will normally have valve caps and chains only.

2.7 VALVES

A. Refer to specification Section 15300 Section 21 05 00.

2.8 DRAIN, RELIEF AND DISCHARGE PIPING

A. All miscellaneous drain, relief and discharge piping shall be Copper Type M or Schedule 40 internally and externally galvanized steel pipe.

PART 3 - EXECUTION

3.1 FINAL FIRE PUMP SIZING

A. Contractor is responsible for determining the final fire pump sizing based on the results of the confirming water flow test and final hydraulic calculations for the sprinkler and standpipe systems.

B. Water supply to be derated by 10 percent of the static pressure at both the static and residual pressures for future degradation.

C. Show all friction loss and elevation changes between the effective point of the hydrant flow test and the supply side of the fire pump.

D. Fire pump maximum discharge pressure not to exceed 175 psi, without the use of extra heavy pattern fittings. Minimum suction pressure must remain over 20 psi at the pump suction.

E. Total fire demand is the sprinkler demand plus inside and outside hose streams.

F. The sprinkler system demand pressure shall be at least 10 percent but not less than 5 psi, less than the available pressure from the system, including the fire pump, when measured at the appropriate point on the fire pump curve. This point shall not exceed 125 percent of the rated capacity of the fire pump.

G. Contractor shall submit all calculations to the Professional for approval prior to ordering the fire pump.

3.2 INSTALLATION

A. Fire pump shall be installed in strict accordance with NFPA 20 and arranged as closely as possible to that indicated on the Contract Documents.

B. Jockey pump shall be installed in accordance with NFPA 20.

C. Controllers shall be installed in accordance with NFPA 20.

D. Fire pump and jockey pump pressure control sensors shall be installed in accordance with NFPA 20.

E. Fire pump drip pan base shall be piped to floor drain.

F. All valves installed in horizontal lines shall be installed with the stems horizontal or above. Valve handwheels shall be oriented, when installed, to provide maximum accessibility for operation.

G. The Electrical Contractor shall provide and connect the power to the controllers. The Fire Protection Contractor shall be responsible for all connections between the controllers and the respective pump.

H. Provide a cabinet with 2 sets of ear muff type hearing protection and a flashlight. Identify cabinet accordingly and mount in proximity to the fire pump controller.

3.3 STORAGE

A. Fire pump, jockey pump and control panels shall be stored on wooden pallets or shipping skids. Pumps and controllers shall be covered with 6 mil polyethylene secured in place.

3.4 PAINTING AND MARKING

A. The Fire Protection Contractor shall paint all pipes within the fire pump room. The color shall be red.

B. All pipe sections shall also be stenciled in accordance with specification Section 15300 Section 21 05 00.

C. All valves shall be provided with metal identification tags indicating the function and normal position (open or closed) as required.

3.5 TESTING

A. The fire pumping system shall be flushed and tested in strict accordance with NFPA 20 13. The entire system shall be hydrostatically tested for 2 hours.

B. The Contractor is responsible for conducting all tests required by the AHJ as well as those specified herein or by NFPA 20.

C. The Contractor shall notify the AHJ and the Professional 5 days or more in advance of all tests to be conducted.

D. All underground piping shall be flushed prior to connection to the pump in accordance with NFPA 24 and documented as such.

E. Any retesting that is required due to failure, for any reason, of any test shall be conducted at no additional cost to the Owner. Any corrections or repairs to the system or building necessary due to such failure, and retesting of the system shall be performed at no cost to the Owner.

F. The Contractor is responsible for providing systems that are acceptable to the AHJ and the Professional.

G. Final acceptance of the systems is based on approval from both the AHJ as well as the Professional.

H. Provide documentation of all testing including certification and confirmation of completion of all NFPA 20 required tests, pump curves, and start and stop pressure settings.

END OF SECTION 21 30 00

SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING 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.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. 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.

2.3 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

C. Motors 1/20 HP and Smaller: Shaded-pole type.

D. 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.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 22 05 13

SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Grout.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Smith, Jay R. Mfg. Co.
2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

1. Sleeves are not required for core-drilled holes.

B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

C. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

D. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6: Use one of the following:

1) Galvanized-steel-pipe sleeves.
2) PVC-pipe sleeves.
3) Stack-sleeve fittings.
4) Molded-PE or -PP sleeves.
5) Molded-PVC sleeves.

b. Piping NPS 6 and Larger: Use one of the following:

1) Galvanized-steel-pipe sleeves
2) PVC-pipe sleeves.
3) Stack-sleeve fittings.

2. Interior Partitions:

   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 22 05 17

SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, exposed-rivet hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and polished, chrome-plated finish.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with exposed-rivet hinge.
g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or split-plate, stamped-steel type with exposed-rivet hinge.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 22 05 18

SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.
6. Test-plug kits.

B. Related Sections:
1. Section 221116 "Domestic Water Piping" for water meters inside the building.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Flo Fab Inc.

b. Miljoco Corporation.
c. Palmer Wahl Instrumentation Group.
d. Tel-Tru Manufacturing Company.
e. Trerice, H. O. Co.
f. Weiss Instruments, Inc.
g. Winters Instruments - U.S.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:
1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMETEK, Inc.; U.S. Gauge.
   b. Ashcroft Inc.
   c. Ernst Flow Industries.
   d. Flo Fab Inc.
   e. Marsh Bellofram.
   f. Miljoco Corporation.
   g. Noshok.

h. Palmer Wahl Instrumentation Group.
i. REOTEMP Instrument Corporation.
j. Tel-Tru Manufacturing Company.
k. Trerice, H. O. Co.
l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
m. Weiss Instruments, Inc.
n. WIKA Instrument Corporation - USA.
o. Winters Instruments - U.S.

2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2 ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flow Design, Inc.
2. Miljoco Corporation.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
8. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. Install test plugs in piping tees.

I. Install thermometers in the following locations:
   1. Inlet and outlet of each water heater.

J. Install pressure gages in the following locations:
   1. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be he following:
   1. Industrial-style, liquid-in-glass type.

B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at suction and discharge of each domestic water pump shall be the following:
   1. Liquid-filled, direct-mounted, metal case.
   2. Test plug with EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Water Piping: 0 to 160 psi.

END OF SECTION 22 05 19

SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bronze angle valves.
2. Brass ball valves.
3. Bronze ball valves.
4. Iron ball valves.
5. Iron, single-flange butterfly valves.
6. Iron, grooved-end butterfly valves.
7. Bronze lift check valves.
8. Bronze swing check valves.
9. Iron swing check valves.
10. Iron, grooved-end swing check valves.
11. Bronze gate valves.
12. Iron gate valves.
13. Bronze globe valves.
14. Iron globe valves.
15. Chainwheels.

B. Related Sections:

1. Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
2. Section 221116 "Domestic Water Piping" for valves applicable only to this piping.
3. Section 221319 "Sanitary Waste Piping Specialties" for valves applicable only to this piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

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 angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug 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 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller[except plug valves].

E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE ANGLE VALVES

A. Class 125, Bronze Angle Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Valve, Inc.
b. NIBCO INC.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.

d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

2.3 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Hammond Valve.
d. Jamesbury; a subsidiary of Metso Automation.
e. Kitz Corporation.
f. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.4 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.5 IRON BALL VALVES

A. Class 125, Iron Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Kitz Corporation.
d. Sure Flow Equipment Inc.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-72.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Split body.
d. Body Material: ASTM A 126, gray iron.
e. Ends: Flanged.
f. Seats: PTFE or TFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel.
i. Port: Full.

2.6 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.

e. DeZurik Water Controls.
f. Hammond Valve.
g. Kitz Corporation.
h. Legend Valve.
i. Milwaukee Valve Company.
j. Mueller Steam Specialty; a division of SPX Corporation.
k. NIBCO INC.
l. Red-White Valve Corporation.
m. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Stainless steel.

2.7 IRON, GROOVED-END BUTTERFLY VALVES

A. 175 CWP, Iron, Grooved-End Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kennedy Valve; a division of McWane, Inc.
b. Shurjoint Piping Products.
c. Tyco Fire Products LP; Grinnell Mechanical Products.
d. Victaulic Company.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 175 psig (1200 kPa).
c. Body Material: Coated, ductile iron.
d. Stem: Two-piece stainless steel.
e. Disc: Coated, ductile iron.
f. Seal: EPDM.

2.8 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

2.9 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Composition.
g. Seat Ring: Bronze.
h. Disc Holder: Bronze.
i. Disc: PTFE or TFE.
j. Gasket: Asbestos free.

2.10 IRON, GROOVED-END SWING CHECK VALVES

A. 300 CWP, Iron, Grooved-End Swing Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.
b. Shurjoint Piping Products.
c. Tyco Fire Products LP; Grinnell Mechanical Products.
d. Victaulic Company.

2. Description:

a. CWP Rating: 300 psig (2070 kPa).
b. Body Material: ASTM A 536, ductile iron.
c. Seal: EPDM.
d. Disc: Spring-operated, ductile iron or stainless steel.

2.11 IRON GATE VALVES

A. Class 125, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Flo Fab Inc.
e. Hammond Valve.
f. Kitz Corporation.
g. Legend Valve.
h. Milwaukee Valve Company.
i. NIBCO INC.
j. Powell Valves.
k. Red-White Valve Corporation.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
m. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

2.12 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. NIBCO INC.
d. Red-White Valve Corporation.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

2.13 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Powell Valves.
i. Red-White Valve Corporation.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
k. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly, or gate valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service: Globe valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
7. For Grooved-End Copper Tubing: Valve ends may be grooved.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125, nonmetallic disc.
3. Ball Valves: Two piece, full port, brass or bronze with stainless-steel trim.
4. Bronze Swing Check Valves: Class 125 nonmetallic disc.
5. Bronze Globe Valves: Class 125, nonmetallic disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves: Class 150.
3. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, stainless-steel disc.
4. Iron, Grooved-End Butterfly Valves: 175 CWP.
5. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
6. Iron, Grooved-End Swing Check Valves: 300 CWP.
7. Iron Gate Valves: Class 125, OS&Y.
8. Iron Globe Valves: Class 125.

END OF SECTION 22 05 23

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING 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. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.
c. Flex-Strut Inc.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut Corporation; Tyco International, Ltd.
g. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Electroplated zinc.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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 or shield for insulated piping.

E. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal 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.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. 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 (DN 65) and larger and at changes in direction of piping..

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
    b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
    c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
    d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
    e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

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 a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099123 "Interior Painting."

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

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), 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 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) 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 (49 to 232 deg C) piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-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 (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 22 05 29

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING 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. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 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 locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
2. Identification Paint: Exterior, alkyd 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.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 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.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

    a. All Services: 1-1/2 inches, round.

2. Valve-Tag Color:

    a. All Services: Natural.

3. Letter Color:

    a. All Services: Black.

3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 22 05 53

SECTION 22 07 19 - PLUMBING PIPING 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 insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Horizontal rainwater piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing system. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM 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. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

G. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.

c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 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. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, 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. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

2.4 SEALANTS

A. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 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 (Minus 40 to plus 121 deg C).
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 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.

2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches (75 mm).
3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of 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. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal 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.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). 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 (50 mm)] [4 inches (100 mm)] o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 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 and polyolefin, 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. 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.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. Tape is not an acceptable substitute for adhered joints and seams.
   1. In addition to longitudinal seam adhesive, provide three tie wraps, spaced evenly, along each four foot section of insulation.

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.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

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. Provide three tie wraps, spaced evenly, along each four foot section of insulation.
   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 (150 mm) o.c.

4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, 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 (25 mm), 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.

3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1 (DN 25) and Smaller: Insulation shall be the following:

a. Flexible Elastomeric: 3/4 inch (19 mm) thick.

2. NPS 1-1/4 (DN 32) and Larger: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch (25 mm) thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 (DN 32) and Smaller: Insulation shall be one of the following:

a. Flexible Elastomeric: 3/4 inch (19 mm) thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.

2. NPS 1-1/2 (DN 40) to 2” (DN 50): Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch (25 mm) thick.

3. NPS 2” (DN 50) and Larger: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch (25 mm) thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

C. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet (3 m) of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch (25 mm) thick.

D. Horizontal Stormwater and Overflow:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch thick.

E. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch thick.

END OF SECTION 22 07 19

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.

B. City of Baltimore Specifications for Materials, Highways, Bridges, Utilities and Incidental Structures, latest edition.

1.2 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for water service and fire-service mains.

B. Utility-furnished products include water meters that will be furnished at the Baltimore City Meter Shop, ready for installation.

1.3 DEFINITIONS

A. DIP: Ductile Iron Pipe.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For water valves and specialties to include maintenance manuals.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water including tapping of water mains.
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. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

D. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

1. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.6 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.

1.7 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, 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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Viega; Plumbing & Heating Systems.

2) NIBCO, Inc.

3) Mid-America Fittings, LLC

b. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.

2.2 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end.

1. Mechanical-Joint, Ductile-Iron Fittings 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 C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

2.3 CORROSION-PROTECTION PIPING ENCASEMENT

A. Encasement for Underground Metal Piping:

1. Standards: ASTM A 674 or AWWA C105.
2. Form: Sheet.
3. Material: LLDPE film of 0.008-inch minimum thickness.
4. Color: Natural.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section "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 shall be any of the following:

1. Soft copper tube, ASTM B 88, Type K joints.

F. Underground water-service piping NPS 3 to NPS 10 shall be the following:
1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed joints.

G. Aboveground and vault water-service piping NPS 3 to NPS 10 shall be the following:

1. Ductile-iron, flanged-end pipe; ductile-iron, flanged-end appurtenances; and flanged joints.

H. Underground Fire-Service-Main Piping NPS 5 to NPS 10 shall be the following:

1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed joints.

3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

A. See Division 33 Section "Common Work Results for Utilities" for piping-system common requirements.

3.4 PIPING INSTALLATION

A. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.

B. Make connections larger than NPS 2 with tapping machine according to the following:

1. Install tapping sleeve and tapping valve 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.

C. 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."

D. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

E. Bury piping with depth of cover over top at least 48 inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:

1. Under Driveways or crossing utilities: With at least 36 inches cover over top.

F. Extend water-service piping and connect to water-supply source and building-water-piping systems 5 feet outside face of building wall in locations and pipe sizes indicated.

1. Terminate water-service piping 5 feet outside building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Plumbing contractor will make connections to building-water-piping systems when those systems are installed.

G. Sleeves are specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

H. Mechanical sleeve seals are specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

I. 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.

J. See Division 22 Section "Domestic Water Piping" for potable-water piping inside the building.

K. See Division 21 Fire Suppression for all fire suppression system piping inside the building.

L. See Division 22 Section "Domestic Water Geothermal Water-Source Heat Pumps" for geothermal system piping inside and outside the building.

3.5 JOINT CONSTRUCTION

A. See Division 22 Section "Domestic Water Piping" and Division 33 Section “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.

3.6 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. Pipe clamps and tie rods.

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.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.8 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Test shall be conducted as prescribed in the City of Baltimore Specifications for Materials, Highways, Bridges, Utilities and Incidental Structures, SECTION 33 11 13, PART I GENERAL, Paragraph 1.4. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test per AWWA C600 at not less than one-and-one-half times working pressure for two hours.

C. Prepare reports of testing activities.

3.9 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 Division 31 Section "Earth Moving."

3.10 CLEANING, CHLORINATION, FLUSHING AND BACTERIOLOGICAL

A. Use purging and disinfecting procedure as prescribed in the City of Baltimore Specifications for Materials, Highways, Bridges, Utilities and Incidental Structures, SECTION 33 11 13, PART I GENERAL, Paragraph 1.4 E.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 221113

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SECTION 22 11 16 - 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Aboveground domestic water pipes, tubes, and fittings inside buildings.

1.3 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of water service.
   2. Do not interrupt water service without Construction Manager's and Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L and water tube, drawn temper.

B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Copper Unions:
1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

F. Copper Pressure-Seal-Joint Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elkhart Products Corporation.
   b. NIBCO Inc.
   c. Viega.
2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

G. Copper-Tube, Extruded-Tee Connections:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. T-Drill Industries Inc.
2. Description: Tee formed in copper tube according to ASTM F 2014.

H. Appurtenances for Grooved-End Copper Tubing:
1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   a. Anvil International.
   b. Shurjoint Piping Products.
   c. Victaulic Company.
2. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75 copper tube or ASTM B 584 bronze castings.
3. Mechanical Couplings for Grooved-End Copper Tubing:
   a. Copper-tube dimensions and design similar to AWWA C606.
   b. Ferrous housing sections.
   c. EPDM-rubber gaskets suitable for hot and cold water.
   d. Bolts and nuts.
   e. Minimum Pressure Rating: 300 psig.

2.3 CPVC PIPING

A. CPVC Pipe: ASTM F 441/F 441M, Schedule 80.

1. CPVC Socket Fittings: ASTM F 439 for Schedule 80.
2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.

2.4 PEX TUBE AND FITTINGS

A. PEX Distribution System: ASTM F 877, SDR 9 tubing.

B. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.

C. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.

2.5 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:
1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
1. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Solvent cement and adhesive primer 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."

F. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.6 TRANSITION FITTINGS

A. General Requirements:
1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Plastic-to-Metal Transition Fittings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Charlotte Pipe and Foundry Company.
b. Harvel Plastics, Inc.
c. Spears Manufacturing Company.
2. Description:
a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

D. Plastic-to-Metal Transition Unions:
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. Colonial Engineering, Inc.
b. NIBCO Inc.
c. Spears Manufacturing Company.
2. Description:
a. CPVC four-part union.
b. Brass[or stainless-steel] threaded end.
c. Solvent-cement-joint or threaded plastic end.
d. Rubber O-ring.
e. Union nut.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
b. Central Plastics Company.
c. Hart Industries International, Inc.
d. Jomar International.
e. Matco-Norca.
f. McDonald, A. Y. Mfg. Co.
g. Watts; a division of Watts Water Technologies, Inc.
h. Wilkins; a Zurn company.
2. Standard: ASSE 1079.
3. Pressure Rating: 125 psig minimum at 180 deg F.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
b. Central Plastics Company.

c. Matco-Norca.
d. Watts; a division of Watts Water Technologies, Inc.
e. Wilkins; a Zurn company.

2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig minimum at 180 deg F.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.
2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Elster Perfection Corporation.
b. Grinnell Mechanical Products; Tyco Fire Products LP.
c. Matco-Norca.
d. Precision Plumbing Products, Inc.
e. Victaulic Company.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

C. Rough-in domestic water piping for water-meter installation according to manufacturer’s requirements.

D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

G. Install piping to permit valve servicing.

H. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

L. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."

M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

N. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

F. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

G. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

H. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

I. Joint Construction for Solvent-Cemented Plastic Piping: 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. Apply primer.
   2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   3. PVC Piping: Join according to ASTM D 2855.

J. Joints for PEX Piping: Join according to ASTM F 1807.

K. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
   2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.4 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flange kits.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. 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.

E. Install supports for vertical copper tubing every 10 feet.

F. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 (DN 25) and Smaller: 36 inches (900 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
3. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
4. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
5. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
6. NPS 8 (DN 200): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.

G. Install supports for vertical CPVC piping every 60 inches (1500 mm) for NPS 1 (DN 25) and smaller, and every 72 inches (1800 mm) for NPS 1-1/4 (DN 32) and larger.

H. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 (DN 25) and Smaller: 32 inches (815 mm) with 3/8-inch (10-mm) rod.

I. Install hangers for vertical PEX piping every 48 inches (1200 mm).

J. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
   2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
   4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.7 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Piping Inspections:
      a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
      b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
         1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
         2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
      c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
      d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
   2. Piping Tests:
      a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 ADJUSTING

A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:
1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.

2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

d. Repeat procedures if biological examination shows contamination.

e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought-copper, solder-joint fittings; and soldered joints.
3. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.
4. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper push-on-joint fittings; and push-on joints.
5. CPVC, Schedule 80; socket fittings; and solvent-cemented joints.
6. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
7. PEX tube, NPS 1 (DN 25) and smaller; fittings for PEX tube; and crimped joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought-copper, solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); grooved-joint, copper-tube appurtenances; and grooved joints.
4. CPVC, Schedule 80; socket fittings; and solvent-cemented joints.
5. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.

3.12 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
   2. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
   3. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 22 11 16

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backflow preventer.
2. Balancing valves.
3. Strainers.
4. Hose bibbs.
5. Drain valves.
6. Water-hammer arresters.
7. Digital Water Tempering Station and Valves
8. Wall Hydrants
9. Yard Hydrant
10. Trap Primer Systems

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 and NSF 14.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Cash Acme; a division of Reliance Worldwide Corporation.
b. Conbraco Industries, Inc.
c. FEBCO; a division of Watts Water Technologies, Inc.
d. Honeywell International Inc.
e. Legend Valve.
f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
g. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Body: Bronze.
5. End Connections: Union, solder joint.
6. Finish: Rough bronze.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
b. Conbraco Industries, Inc.
c. FEBCO; a division of Watts Water Technologies, Inc.
d. Flomatic Corporation.
e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle third of flow range.

5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight-through flow.
8. Accessories:

    a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Double-Check, Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
    b. Conbraco Industries, Inc.
    c. FEBCO; a division of Watts Water Technologies, Inc.
    d. Flomatic Corporation.
    e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight-through flow.
8. Accessories:

    a. ValvesNPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    b. ValvesNPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

D. Beverage-Dispensing-Equipment Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Conbraco Industries, Inc.
    b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1022.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8.
5. Body: Stainless steel.
6. End Connections: Threaded.

2.4 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. Flo Fab Inc.
    c. ITT Corporation; Bell & Gossett Div.
    d. NIBCO Inc.
    e. TAC.
    f. TACO Incorporated.
    g. 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.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron[with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and] for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 and Smaller: 0.020 inch.
    b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
    c. Strainers NPS 5 and Larger: 0.10 inch.

6. Drain: Pipe plug.

2.6 HOSE BIBBS

A. Hose Bibbs :

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.

7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.7 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.8 Digital RE-CIRCULATING VALVE TEMPERING STATION

A. Digital Re-Circulating Valve shall be supplied pre-piped and pressure tested as a lead free Digital Mixing Center complete with inlet hot water, inlet cold water, outlet mixed water, inlet re-circulation return water and outlet return to heater water connections.

B. DMC shall comprise check valves, strainers, thermometers, pressure gauges, ball valves, inlet hot water to outlet mixed water by-pass and shall be mounted onto an enameled steel frame.

C. Manufacturers:

1. Arrnstrong International, Inc.- Model DMC40 and DMC 50
2. Alternate manufacturers offering products with similar quality and performance. Contractor shall propose modifications required to the design to use these systems.

a. Lawler Manufacturing Company, Inc.
b. Leonard Valve Company.
c. Powers; a division of Watts Water Technologies, Inc.
d. Symmons Industries, Inc.

D. DIGITAL RE-CIRCULATING VALVE (DRV)

1. Re-Circulating Valve shall be digital of lead free stainless steel/polymer construction.
2. DRV for the Kitchen hot water supply shall have 1 ½" inlet/outlet connections, deliver a mixed water flow of 41GPM @ 7.5ft/sec and shall have no minimum system draw off requirement.
3. DRV for the main building hot water supply shall have 2" inlet/outlet connections, deliver a mixed water flow of 73 GPM @ 7.5ft/sec and shall have no minimum system draw off requirement
4. DRV shall have all of the following operational capabilities:

a. +/- 2F water temperature control
b. 2F minimum inlet to outlet water temperature differential
c. Automatic shutoff of hot water flow upon cold water inlet supply failure.
d. Automatic shutoff of hot water flow in the event of a power failure
e. Programmable set point range of 81-158°F (27-70°C)
f. Programmable thermal disinfection mode
g. Programmable 1st level hi/lo temp alarm display
h. Programmable temperature error level for safety shutdown

5. DRV shall have all of the following connectivity capabilities:

a. SPCO relay outputs which are energized during operation.
b. LCD display which indicates: set point, delivered temperature, error codes and alarm conditions.
c. MODBUS 485 port for remote set point adjustment and remote operating temperature visibility.
d. RS485 Serial Port for connection to a performance matched hot water monitoring system.

6. DRV shall be compliant with ASSE Standard 1017 and CSA B125 and so certified and identified.
7. DRV shall be UL listed and identified.

2.9 WALL HYDRANTS

A. Nonfreeze Wall Hydrants, WH-1:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Josam Company.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

d. Tyler Pipe; Wade Div.
e. Watts Drainage Products.
f. Woodford Manufacturing Company; a division of WCM Industries, Inc.
g. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.

2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Polished nickel bronze.
12. Operating Keys(s): One with each wall hydrant.

B. Moderate-Climate Wall Hydrants, WH-2:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Josam Company.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products.
f. Woodford Manufacturing Company; a division of WCM Industries, Inc.
g. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.

2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig (860 kPa).
4. Operation: Loose key.
5. Inlet: NPS 3/4 (DN 20).
6. Outlet:

a. Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
b. Garden-hose thread complying with ASME B1.20.7.

7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze.

9. Nozzle and Wall-Plate Finish: Polished nickel bronze.
10. Operating Keys(s): One with each wall hydrant.

2.10 YARD HYDRANTS

A. Nonfreeze, Draining-Type Yard Hydrants YH-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. MIFAB, Inc.
b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
c. Tyler Pipe; Wade Div.
d. Watts Drainage Products.
e. Woodford Manufacturing Company; a division of WCM Industries, Inc.
f. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products; model Z-1396XL.

2. Standard: ASME A112.21.3M.
3. Type: Nonfreeze, exposed-outlet post hydrant.
4. Operation: Lift handle.
5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
6. Casing: Bronze with casing guard.
7. Inlet: NPS 3/4 (DN 20).
8. Outlet: Garden-hose thread complying with ASME B1.20.7.
9. Drain: Designed with hole to drain into ground when shut off.
10. Vacuum Breaker:
    a. Not required. A double check backflow preventer is provided in the building.

2.11 TRAP SEAL PROTECTION

A. Trap Guard: Sewage gas and sewage back up protection for floor drains suitable for installation/retrofit in the piping or floor drain of any manufacturer.

1. Material: Smooth, soft, flexible, elastomeric PVC material molded into the shape of a duck's bill, open on top and curl closure at bottom.
2. Allows wastewater to open and adequately discharge floor drain through its interior.
3. Closes and returns to original molded shape after wastewater discharge is complete
4. Complies with ASME A112.6.3.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.

2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Install balancing valves in locations where they can easily be adjusted.

C. Install Y-pattern strainers for water on supply side of each pump.

D. Install water-hammer arresters in water piping according to PDI-WH 201.

E. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Calibrated balancing valves.

3.4 FIELD QUALITY CONTROL

A. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

3.5 ADJUSTING

A. Set field-adjustable flow set points of balancing valves.

1. Submit balancing report indicating actual flow at each balancing valve.

B. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 22 11 19

SECTION 22 11 23.13 - DOMESTIC-WATER PACKAGED BOOSTER 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. Section Includes:

1. Multiplex, variable-speed booster pumps.

B. Related Sections:

1. Section 221123 "Domestic Water Pumps" for domestic-water circulation pumps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, and dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For booster pumps. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For booster pumps 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, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Comply with ASME B31.9 for piping.

C. UL Compliance for Packaged Pumping Systems:

1. UL 508, "Industrial Control Equipment."
2. UL 508A, "Industrial Control Panels."
3. UL 778, "Motor-Operated Water Pumps."
4. UL 1995, "Heating and Cooling Equipment."

D. Booster pumps shall be listed and labeled as packaged pumping systems by testing agency acceptable to authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain protective coatings and flange's protective covers during storage.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 MULTIPLEX, VARIABLE-SPEED BOOSTER PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong Pumps Inc.
2. Bell & Gossett Domestic Pump; ITT Corporation.
3. Canariis Corporation.
4. Goulds Pumps; ITT Corporation.
5. Grundfos Pumps Corporation U.S.A.
6. Penn Pump; model PB-3040-2
7. SyncroFlo, Inc.
8. TIGERFLOW Systems, Inc.

B. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.

C. Pumps:

1. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
2. Casing: Bronze fitted cast iron.
3. Impeller: Closed, ASTM B 584 cast bronze or stainless steel; statically and dynamically balanced and keyed to shaft.
4. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
5. Seal: Mechanical.
6. Orientation: Mounted horizontally or vertically.

D. Motors: Single speed, with grease-lubricated or pre-greased, permanently shielded, ball-type bearings. Select motors that will not overload through full range of pump performance curve.

E. Piping: Copper tube and copper fittings.

F. Valves:

1. Shutoff Valves NPS 2 and smaller: Gate valve or two-piece, full-port ball valve, in each pump's suction and discharge piping.
2. Shutoff Valves NPS 2-1/2 and Larger: Gate valve or lug-type butterfly valve, in each pump's suction and discharge piping and in inlet and outlet headers.
3. Control Valves: Combination adjustable, automatic, pilot-operated or direct-acting pressure-reducing-and-Bronze check valve in each pump's discharge piping.
4. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.

G. Dielectric Fittings: With insulating material isolating joined dissimilar metals.

H. Control Panel: Factory installed and connected as an integral part of booster pump; automatic for multiple-pump, variable-speed operation, with load control and protection functions.

1. Control Logic: Solid-state system with transducers, programmable microprocessor, VFC, and other devices in the controller.
2. Motor Controller: NEMA ICS 2, variable frequency, solid state type.

    a. Control Voltage: 24 V ac, with integral control-power transformer.

3. Enclosure: NEMA 250, Type 1.
4. Motor Overload Protection: Overload relay in each phase.
5. Starting Devices: Hand-off-automatic selector switch for each pump in cover of control panel, plus pilot device for automatic control.

    a. Triplex, Sequence (Lead-Lag-Lag) Starter: Switches lead pump to one lag main pump and to three-pump operation.

6. Pump Operation and Sequencing: Pressure-sensing method.

    a. Time Delay: Controls pump on-off operation; adjustable from 1 to 300 seconds.

7. VFC: Voltage source, pulse width, modulating frequency converter for each pump.
8. Manual Bypass: Magnetic contractor arranged to transfer to constant speed operation upon VFC failure.
9. Instrumentation: Suction and discharge pressure gages.
10. Lights: Running light for each pump.
11. Alarm Signal Device: Sounds alarm when backup pumps are operating.

    a. Time Delay: Controls alarm operation; adjustable from 1 to 300 seconds, with manual reset.

12. Thermal-bleed cutoff.
13. Low-suction-pressure cutout.

14. High-suction-pressure cutout.
15. Low-discharge-pressure cutout.
16. High-discharge-pressure cutout.
17. Building Automation System Interface: Provide auxiliary contacts for interface to building automation system. Building automation systems are specified in Section 230900 "Instrumentation and Control for HVAC." Include the following:

    a. On-off status of each pump.
    b. Alarm status.

I. Base: Structural steel.

J. Capacities and Characteristics:

1. As scheduled on drawings.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in NFPA 70.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

3.3 INSTALLATION

A. Equipment Mounting: Install booster pumps on concrete base using elastomeric pads. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Minimum Deflection: 1/4 inch.
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 concrete 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.

B. Support connected domestic-water piping so weight of piping is not supported by booster pumps.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect domestic-water piping to booster pumps. Install suction and discharge pipe equal to or greater than size of system suction and discharge headers.

1. Install shutoff valves on piping connections to booster-pump suction and discharge headers. Install ball, butterfly, or gate valves same size as suction and discharge headers. Comply with requirements for general-duty valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Install union, flanged, or grooved-joint connections on suction and discharge headers at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Section 221116 "Domestic Water Piping."
3. Install valved bypass, same size as and between piping, at connections to booster-pump suction and discharge headers. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."
4. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge headers. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."
5. Install piping adjacent to booster pumps to allow service and maintenance.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
1. Perform visual and mechanical inspection.
2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

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. Adjust booster pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust pressure set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train. Owner's maintenance personnel to adjust, operate, and maintain booster pumps.

END OF SECTION 22 11 23.13

SECTION 22 11 23 - DOMESTIC WATER 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. Section Includes:

1. In-line, sealless centrifugal pumps.
2. Horizontally mounted, in-line, close-coupled centrifugal pumps.

1.3 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water pumps to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.7 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 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong Pumps Inc.
2. Bell & Gossett Domestic Pump; ITT Corporation.
3. Grundfos Pumps Corp.
4. TACO Incorporated.

B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

C. Pump Construction:

1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
2. Casing: Bronze, with threaded or companion-flange connections.
3. Impeller: Plastic.
4. Motor: Single speed, unless otherwise indicated.

D. Capacities and Characteristics:

1. As scheduled drawings.

2.2 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alyan Pump Co.
2. Armstrong Pumps Inc.
3. Bell & Gossett Domestic Pump; ITT Corporation.
4. Marshall Engineered Products Co.
5. PACO Pumps; Grundfos Pumps Corporation, U.S.A.
6. Pentair Pump Group; Aurora Pump.
7. TACO Incorporated.
8. Thrush Company, Inc.

B. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.

C. Pump Construction:

1. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections.
2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
4. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
5. Bearings: Oil-lubricated; bronze-journal or ball type.
6. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

D. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.

E. Capacities and Characteristics:

1. As scheduled on drawings.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 65 to 200 deg F (18 to 93 deg C).
3. Enclosure: NEMA 250.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 120 V, ac.
7. Settings: Start pump at 105 deg F (41 deg C) and stop pump at 110 deg F (49 deg C).

B. Timers: Electric, for control of hot-water circulation pump.

1. Type: Programmable, seven-day clock with manual override on-off switch.

2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 120-V ac.
6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Install in-line, sealless centrifugal pumps OR horizontally mounted, in-line, close-coupled centrifugal pumps for hot water recirculation where shown on the drawings.

B. Comply with HI 1.4.

C. Install in-line, sealless centrifugal pumps with shaft horizontal unless otherwise indicated.

D. Install horizontally mounted, in-line, close-coupled centrifugal pumps with shaft(s) horizontal.

E. Install thermostats in hot-water return piping.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

a. Horizontally mounted, in-line, close-coupled centrifugal pumps.
b. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."

2. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping" and comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties."
3. Install pressure gage and snubber across suction and discharge of each pump. Comply with requirements for pressure gages and snubbers specified in Section 220519 "Meters and Gages for Plumbing Piping."

D. Connect thermostats, to pumps that they control.

3.4 IDENTIFICATION

A. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.5 ADJUSTING

A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 22 11 23

SECTION 22 12 23 - FACILITY INDOOR POTABLE-WATER STORAGE TANKS

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. Insulated, steel, potable-water storage tanks.

1.3 DEFINITIONS

A. HDPE: High-density polyethylene plastic.

B. LDPE: Low-density polyethylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water storage tanks.
2. Include rated capacities, operating characteristics, and furnished specialties, accessories and minimum R-value.

B. Product Certificates: For each type of potable-water storage tank, from manufacturer.

C. Source quality-control reports.

D. Purging and disinfecting reports.

1.5 QUALITY ASSURANCE

A. ASME Compliance for Steel Tanks: Fabricate and label steel, ASME-code, potable-water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 01.

B. Comply with NSF 61, "Drinking Water System Components - Health Effects," for potable-water storage tanks. Include appropriate NSF marking.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 INSULATED, STEEL, POTABLE-WATER STORAGE TANKS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Laars Heating Systems Company.
2. Lochinvar Corporation.
3. Precision Boilers.
4. PVI Industries, LLC.
5. RBI; a Mestek company.
6. Rheem Manufacturing Company.
7. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
8. State Industries, Inc.
9. Wessels Company.

B. Description: Steel, vertical, pressure-rated tank with cylindrical sidewalls.

C. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

D. Construction: ASME code, steel, constructed with nontoxic welded joints, for 125-psig (860-kPa) working pressure.

E. Manhole: Watertight, for tank more than 36 inches (915 mm) in diameter; same pressure rating as tank.

F. Tappings: Factory-fabricated stainless steel, welded to tank before testing and labeling.

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

G. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Thermometer.

H. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank before testing and labeling.

I. Tank Interior Finish: Materials and thicknesses complying with NSF 61 barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

1. Lining Material: Cement.

J. Insulation: Factory-installed fiberglass or polyurethane foam; surrounding entire tank except connections and other openings; suitable for tank operating temperature; and complying with ASHRAE/IESNA 90.1.

K. Jacket: Steel, with manufacturer's standard finish unless otherwise indicated.

2.2 SOURCE QUALITY CONTROL

A. Test and inspect potable-water storage tanks according to the following tests and inspections and prepare test reports:

1. Pressure Testing for ASME-Code, Potable-Water Storage Tanks: Hydrostatically test to ensure structural integrity and freedom from leaks. Fill tanks with water, vent air, pressurize to 1-1/2 times tank pressure rating, disconnect test equipment, hold pressure for 30 minutes with no drop in pressure, and check for leaks.

B. Repair or replace tanks that fail test with new tanks, and repeat until test is satisfactory.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water storage tanks on concrete bases, level and plumb, firmly anchored. Arrange so devices needing servicing are accessible.

B. Anchor tank supports and tanks to substrate.

C. Install thermometers and pressure gages on water storage tanks and piping if indicated. Thermometers and pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping."

D. Install the following devices on tanks:

1. Temperature and pressure relief valves.
2. Vacuum relief valves.
3. Connections to accessories.

E. After installing tanks with factory finish, inspect finishes and repair damages to finishes.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to potable-water storage tanks to allow service and maintenance.

C. Connect water piping to water storage tanks with unions or flanges and with shutoff valves. Connect tank drains with shutoff valves and discharge over closest floor drains.

1. General-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

    a. Valves NPS 2 and Smaller: Gate or ball.
    b. Valves NPS 2-1/2 and Larger: Gate or butterfly.
    c. Drain Valves: NPS 3/4 gate or ball valve. Include outlet with, or nipple in outlet with, ASME B1.20.7, 3/4-11.5NH thread for garden-hose service, threaded cap, and chain.

2. Water Piping Connections: Make connections to dissimilar metals with dielectric fittings. Dielectric fittings are specified in Division 22 Section "Domestic Water Piping."

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following final checks before filling:

1. Test operation of tank accessories and devices.
2. Verify that pressure relief valves have correct setting.

    a. Manually operate pressure relief valves.
    b. Adjust pressure settings.

3. Verify that vacuum relief valves are correct size.

    a. Manually operate vacuum relief valves.
    b. Adjust vacuum settings.

B. Filling Procedures: Follow manufacturer's written procedures. Fill tanks with water to operating level.

3.5 CLEANING

A. Clean and disinfect potable-water storage tanks.

B. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed, use procedure described in AWWA C652 or as described below:

1. Purge water storage tanks with potable water.
2. Disinfect tanks by 1 of the following methods:

    a. Fill tanks with water-chlorine solution containing at least 50 ppm of chlorine. Isolate tanks and allow to stand for 24 hours.

b. Fill tanks with water-chlorine solution containing at least 200 ppm of chlorine. Isolate tanks and allow to stand for 3 hours.

3. Flush tanks, after required standing time, with clean, potable water until chlorine is not present in water coming from tank.
4. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination made by authorities having jurisdiction shows evidence of contamination.

C. Prepare written reports for purging and disinfecting activities.

END OF SECTION 22 12 23

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.

B. City of Baltimore Specifications for Materials, Highways, Bridges, Utilities and Incidental Structures, latest edition.

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Non-pressure and pressure couplings.
3. Expansion joints and deflection fittings.
4. Cleanouts.
5. Encasement for piping.
6. Manholes.

1.3 DEFINITIONS

A. PVC: Polyvinylchloride plastic.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Expansion joints and deflection fittings.
2. Backwater valves.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

C. Product Certificates: For each type of pipe and fitting, from manufacturer.

D. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.6 PROJECT 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 Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D 3034, SDR 35, 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.

2.2 CLEANOUTS

A. PVC Cleanouts:

1. Description: PVC body with bronze threaded plug. Include PVC sewer pipe fitting and riser to clean-out of same material as sewer piping per Baltimore City Standard Details BC 831.29 and BC 830.15.

2.3 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478 precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 8-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.

5. Riser Sections: 5-inch minimum thickness, of length to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 443 and C361, bitumen or butyl rubber per Baltimore City Standard Detail BC 831.04.
8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection per Baltimore City Standard Detail BC 831.04.
9. Steps: Conform to Baltimore City Standard Detail BC 831.32. Omit steps if total depth from floor of manhole to finished grade is less than 5 feet.
10. Grade Rings: Brick and mortar conforming to Baltimore City Standard Detail BC 831.04. Height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 30-inch ID by 9-inch riser, with 3 3/32 inch minimum-width flange and 32-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: A48, Class 30B ductile iron unless otherwise indicated.

C. Manhole-Cover Inserts:

1. Description; Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
2. Type: Valve.

D. Manhole Channels and Benches: Bench and channel to be constructed of one course of sewer brick on edge. Bench to slope a minimum of 1” per foot towards channel.

1. Bench Height: Bench height above the outgoing pipe invert to be equal to the diameter of the outgoing pipe or as directed by the Engineer.

a. Invert Slope: 2 percent through manhole.

E. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615, Grade 60 (420 MPa) deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details 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, non-pressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
3. Install piping with 36-inch minimum cover.

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:
1. Join PVC 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.

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. Form continuous concrete channels and benches between inlets and outlet.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

E. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.6 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use PVC pipe fittings in sewer pipes at branches for cleanouts, and use PVC pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.7 CONNECTIONS

A. Connect non-pressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi
2. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.

b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

3. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.8 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 following procedure:

1. Close open ends of piping with at least 8-inch- thick, brick masonry bulkheads.

B. Abandoned Manholes: Excavate around manhole as required and abandon manholes in accordance with Baltimore City Standard Detail BC 831.10.

C. Backfill to grade according to Division 31 Section "Earth Moving."

3.9 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use non-detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.10 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

    a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
    b. Close openings in system and fill with water.
    c. Purge air and refill with water.
    d. Disconnect water supply.
    e. Test and inspect joints for leaks.

6. Manholes: Perform hydraulic test according to ASTM C 969.

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.

3.11 CLEANING

A. Clean dirt and superfluous material from interior of piping with potable water.

END OF SECTION 221313

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SECTION 22 13 16 - 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. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Construction Manager's and Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.

    a. ANACO-Husky.
    b. Dallas Specialty & Mfg. Co.
    c. Fernco Inc.
    d. Matco-Norca, Inc.
    e. MIFAB, Inc.
    f. Mission Rubber Company; a division of MCP Industries, Inc.
    g. Stant.
    h. Tyler Pipe.

2. Standards: ASTM C 1277 and CISPI 310.
3. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and listed by NSF International.
4. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.

B. Galvanized-Cast-Iron Drainage Fittings: ASME B16.12, threaded.

C. Steel Pipe Pressure Fittings:

1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Cast-Iron Flanges: ASME B16.1, Class 125.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.4 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

E. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.5 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.
1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Solvent Cement: ASTM D 2564.
1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Dallas Specialty & Mfg. Co.
      2) Fernco Inc.
      3) Mission Rubber Company; a division of MCP Industries, Inc.
      4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
   b. Standard: ASTM C 1173.
   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
   d. Sleeve Materials:
      1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
4. Shielded, Nonpressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cascade Waterworks Mfg. Co.
      2) Mission Rubber Company; a division of MCP Industries, Inc.
   b. Standard: ASTM C 1460.
   c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
5. Pressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cascade Waterworks Mfg. Co.
      2) Dresser, Inc.
      3) EBAA Iron, Inc.
      4) JCM Industries, Inc.
      5) Romac Industries, Inc.
      6) Smith-Blair, Inc.; a Sensus company.
      7) The Ford Meter Box Company, Inc.
      8) Viking Johnson.
   b. Standard: AWWA C219.
   c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
   d. Center-Sleeve Material: Manufacturer's standard.

e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. 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 coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. 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. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. 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.

K. 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.

L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install aboveground PVC piping according to ASTM D 2665.

N. Install underground PVC piping according to ASTM D 2321.

O. 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."

P. Install steel piping according to applicable plumbing code.

Q. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

R. Install aboveground PVC piping according to ASTM D 2665.

S. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

T. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

U. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

A. 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.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

D. Plastic, Nonpressure-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. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Shielded, nonpressure transition couplings.

3.4 VALVE INSTALLATION

A. General valve installation requirements are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Backwater Valves: Install backwater valves in piping subject to backflow.

   1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
   2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
   3. Install backwater valves in accessible locations.
   4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Vertical Piping: MSS Type 8 or Type 42, clamps.
3. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

4. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
5. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one 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 and NPS 8: 60 inches with 3/4-inch rod.
5. 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. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

K. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.

L. Install supports for vertical PVC piping every 48 inches.

M. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
2. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
3. Comply with requirements for backwater valves cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

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 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 AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be any of the following:
1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
2. Galvanized-steel pipe, drainage fittings, and threaded joints.
3. Copper DWV tube, copper drainage fittings, and soldered joints.
4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints. For Alternate Bids M-A2.
5. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger shall be any of the following:
1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
2. Galvanized-steel pipe, drainage fittings, and threaded joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints. For Alternate Bids M-A2.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 (DN 100) and smaller shall be any of the following:
1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
2. Galvanized-steel pipe, drainage fittings, and threaded joints.
3. Copper DWV tube, copper drainage fittings, and soldered joints.

a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2 (DN 65 and DN 90): Hard copper tube, Type M (Type C); copper pressure fittings; and soldered joints.
4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints. For Alternate Bids M-A2.
5. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

E. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller shall be any of the following:
1. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; and coupled joints.
2. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints. For Alternate Bids M-A3.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

F. Underground, soil and waste piping NPS 5 (DN 125) and larger shall be any of the following:
1. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; coupled joints.
2. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints. For Alternate Bids M-A3.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

G. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 (DN 40 and DN 50) shall be any of the following:

1. Hard copper tube, Type L (Type B); copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

END OF SECTION 22 13 16

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backwater valves.
2. Cleanouts.
3. Floor Drains
4. Trench Drains
5. Air-admittance valves.
6. Miscellaneous sanitary drainage piping specialties.
7. Flashing materials.
8. Solids Interceptor
9. Grease Interceptor

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: Hubless.
7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

2.2 CLEANOUTS

A. Exposed Metal Cleanouts, CO:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.

f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts, FCO:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation; ZN1400-4NL.

2. Standard: ASME A112.36.2M for adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Spigot.
8. Closure: Plastic plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Polished nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Light Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts, WCO:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation; Z-1446.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, stainless-steel cover plate with screw.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains, FD-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation; Z-415.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Membrane Clamp: Reuired.
6. Seepage Flange: Required.
7. Outlet: Bottom.
8. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
9. Top or Strainer Material: Polished Nickel bronze.
10. Top of Body and Strainer Finish: Polished Nickel bronze.
11. Top Shape: Round.
12. Dimensions of Top or Strainer: 5” diameter with heel proof square openings.
13. Top Loading Classification: Light Duty.
14. Trap Material: Cast iron.
15. Trap Pattern: Deep-seal P-trap.

B. Cast-Iron Floor Drains, FD-2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation; Z-550-Y.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Clamping Device: Required.
7. Outlet: Bottom.

8. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
9. Sediment Bucket: Required.
10. Top or Strainer Material: Gray iron.
11. Top of Body and Strainer Finish: Gray iron.
12. Top Shape: Round.
13. Dimensions of Top or Strainer: 9” diameter
14. Top Loading Classification: Medium Duty.
15. Trap Material: Cast iron.
16. Trap Pattern: Deep-seal P-trap.
17. Trap Features: Trap-seal primer valve drain connection.

C. Cast-Iron Floor Sink, FS-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products Inc.
    f. Zurn Plumbing Products Group; Specification Drainage Operation; Z-566.

2. Standard: ASME A112.6.3.
3. Pattern: Floor sink.
4. Body Material: Gray iron.
5. Outlet: Bottom.
6. Sediment Bucket: Not required. Provide secondary strainer.
7. Top or Strainer Material: Gray iron.
8. Top of Body and Strainer Finish: Gray iron.
9. Top Shape: Square.
10. Dimensions of Top or Strainer: 12” x 12”
11. Top Loading Classification: Medium Duty.
12. Trap Material: Cast iron.
13. Trap Pattern: Deep-seal P-trap.
14. Trap Features: Trap-seal primer valve drain connection.

2.4 TRENCH DRAINS

A. FRP Channel Drainage Systems, TD-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ACO Polymer Products, Inc.
    b. Aquaduct, Inc.; an ACO Polymer Products, Inc. Company.
    c. Josam Company; Mea-Josam Div.
    d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    e. Zurn Plumbing Products Group; Flo-Thru Operation.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

    a. Channel Sections: Interlocking-joint, sloped-invert, FRP modular units, with end caps. Include flat, rounded, or inclined inside bottom, with outlets in number, sizes, and locations indicated.

        1) Dimensions: 4 inches (102 mm) wide channel. Include number of units required to form total lengths required to span equipment as shown on the drawings.
        2) Frame: Stainless steel for grates.

    b. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

        1) Material: Reinforced slotted Stainless steel grate – Class C. Cut or leave gaps in grate for discharge from equipment.
        2) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

    c. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
    d. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.5 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves, AAV:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Ayrlett, LLC.
    b. Durgo, Inc.
    c. Oatey.
    d. ProSet Systems Inc.
    e. RectorSeal.
    f. Studor, Inc.

2. Standard: ASSE 1051, Type A for single fixture.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected fixture or branch vent piping.

2.6 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

a. NPS 2 (DN 50): 4-inch- (100-mm-) minimum water seal.
b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

D. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

F. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.7 FLASHING MATERIALS

A. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.

B. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

2.8 SOLIDS INTERCEPTORS

A. Solids Interceptors, SI-1:

1. Products:

a. Josam Co.
b. Rockford Sanitary Systems, Inc.
c. Smith, Jay R. Mfg. Co.
d. Tyler Pipe, Wade Div.
e. Watts Industries, Inc., Drainage Products Div.
f. Zurn Industries, Inc., Specification Drainage Operation.

2. Body Material: Cast iron or steel.
3. Interior Separation Device: Screens.
4. Interior Lining: Corrosion-resistant enamel.
5. Exterior Coating: Corrosion-resistant enamel.
6. Inlet and Outlet Size: 1 ½”
7. End Connections: Threaded.
8. Mounting: Inline below sink.

2.9 GREASE INTERCEPTORS

A. Grease Interceptors: Precast concrete complying with ASTM C 913.

1. Include rubber-gasketed joints, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.
2. Structural Design Loads:
   a. Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
3. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into interceptor walls, for each pipe connection.
4. 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 interceptor to finished grade is less than 60 inches.
5. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover.
6. Manhole Frames and Covers: 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.

a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
b. Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.
c. Include indented top design with lettering cast into cover, using wording equivalent to "GREASE INTERCEPTOR."

B. Capacities and Characteristics:

1. Number of Compartments: Two.
2. Retention Capacity: 1000 gal.
3. Inlet and Outlet Pipe Size: 4" NPS (DN).
4. Trapped Outlet Required: No.
5. Vent Pipe Size: Not required.
6. Installation Position: Underground with manhole riser to grade.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. 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 (DN 100). Use NPS 4 (DN 100) 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 (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Assemble open drain fittings and install with top of hub 2 inches (51 mm) above floor.

E. Install deep-seal traps on floor drains and other waste outlets, if indicated.

F. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

G. Install fixture air-admittance valves on fixture drain piping.

H.

I. Install piping adjacent to equipment to allow service and maintenance.

3.2 FLASHING INSTALLATION

A. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.

B. Secure flashing into sleeve and specialty clamping ring or device.

3.3 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19

SECTION 22 14 13 - FACILITY 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. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Drainage Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Storm-Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of storm-drainage service.

2. Do not proceed with interruption of storm-drainage service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ANACO-Husky.
    b. Dallas Specialty & Mfg. Co.
    c. Fernco Inc.
    d. Matco-Norca, Inc.
    e. MIFAB, Inc.
    f. Mission Rubber Company; a division of MCP Industries, Inc.
    g. Stant.
    h. Tyler Pipe.

2. Standards: ASTM C 1277 and CISPI 310.
3. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and listed by NSF International.
4. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ANACO-Husky.
    b. Clamp-All Corp.
    c. Dallas Specialty & Mfg. Co.
    d. MIFAB, Inc.
    e. Mission Rubber Company; a division of MCP Industries, Inc.
    f. Stant.
    g. Tyler Pipe.

2. Standards: ASTM C 1277 and ASTM C 1540.

3. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and listed by NSF International.
4. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.
1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Solvent Cement: ASTM D 2564.
1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Dallas Specialty & Mfg. Co.
      2) Fernco Inc.
      3) Mission Rubber Company; a division of MCP Industries, Inc.
      4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
   b. Standard: ASTM C 1173.
   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
   d. Sleeve Materials:
      1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
4. Shielded, Nonpressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cascade Waterworks Mfg. Co.
      2) Mission Rubber Company; a division of MCP Industries, Inc.

b. Standard: ASTM C 1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Pressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cascade Waterworks Mfg. Co.
      2) Dresser, Inc.
      3) EBAA Iron, Inc.
      4) JCM Industries, Inc.
      5) Romac Industries, Inc.
      6) Smith-Blair, Inc.; a Sensus company.
      7) The Ford Meter Box Company, Inc.
      8) Viking Johnson.
   b. Standard: AWWA C219.
   c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
   d. Center-Sleeve Material: Manufacturer's standard.
   e. Gasket Material: Natural or synthetic rubber.
   f. Metal Component Finish: Corrosion-resistant coating or material.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. 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 from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. 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. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. 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.

K. 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.

L. Install storm drainage piping at the following minimum slopes unless otherwise indicated:

1. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

M. Install aboveground PVC piping according to ASTM D 2665.

N. Install underground PVC piping according to ASTM D 2321.

O. 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."

P. Install aboveground PVC piping according to ASTM D 2665.

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

A. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

B. Plastic, Nonpressure-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. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.

    a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
    b. NPS 2 and Larger: Pressure transition couplings.

3.4 VALVE INSTALLATION

A. General valve installation requirements are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Install backwater valves in accessible locations.
3. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one 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 and NPS 8: 60 inches with 3/4-inch rod.
5. Spacing for 10-foot pipe 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. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.

H. Install supports for vertical PVC piping every 48 inches.

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
2. Comply with requirements for backwater valves cleanouts and drains specified in Section 221423 "Storm Drainage Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.7 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

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 until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

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.

3.10 PIPING SCHEDULE

A. Aboveground, storm drainage piping NPS 4 (DN 100) and smaller shall be any of the following:
1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints. For Alternate Bids M-A2.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

B. Aboveground, storm drainage piping NPS 5 (DN 125) and larger shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
   2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints. For Alternate Bids M-A2.
   3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Underground, storm drainage piping NPS 4 (DN 100) and smaller shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; and coupled joints.
   2. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints. For Alternate Bids M-A3.
   3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Underground, storm drainage piping NPS 5 (DN 125) and larger shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; coupled joints.
   2. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints. For Alternate Bids M-A3.
   3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 22 14 13

SECTION 22 14 23 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Roof drains.
2. Cleanouts.
3. Flashing materials.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

A. Combination Primary and Secondary Roof Drains, RD-1: Comply with ASME A112.21.2M.

1. Application: Primary and secondary roof drains.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Co.
    b. Smith, Jay R. Mfg. Co.
    c. Tyler Pipe, Wade Div.
    d. Watts Industries, Inc., Drainage Products Div.
    e. Zurn Industries, Inc., Specification Drainage Operation; Z-163EA.

3. Body Material: Cast iron.
4. Dimensions of Body: Two at 11-1/2” diameter

5. Combination Flashing Ring and Gravel Stop: Required.
6. Outlet: Bottom or side as required.
7. Dome Material: Aluminum.
8. Extension Collars: As required.
9. Underdeck Clamp.
10. Sump Receiver: Not Required

B. Cast-Iron, Large-Sump, Primary Roof Drains RD-2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.; model Z-100 EARC

2. Standard: ASME A112.6.4, for general-purpose roof drains.
3. Body Material: Cast iron.
4. Dimension of Body: Nominal 15-inch diameter.
5. Combination Flashing Ring and Gravel Stop: Required.
6. Flow-Control Weirs: Not required.
7. Outlet: Bottom.
8. Extension Collars: Required.
9. Underdeck Clamp: Required.
10. Sump Receiver Plate: Required.
11. Dome Material: PE.

2.2 CLEANOUTS

A. Test Tees:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company.
   b. Smith, Jay R. Mfg. Co.
   c. Tyler Pipe.
   d. Watts Water Technologies, Inc.
   e. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
3. Size: Same as connected drainage piping.
4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure Plug: Countersunk or raised head, brass.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cleanout Ferrule - CO: Where plumbing specialties of this designation are indicated, provide products complying with the following:

1. Applicable Standard: ASME A112.36.2M.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Co.
b. Smith: Jay R. Smith Mfg. Co.
c. Tyler Pipe, Wade Div.
d. Watts Industries, Inc., Ancon Drain Div.
e. Z-1470; Zurn Industries, Inc., Hydromechanics Div.

3. Application: For installation in concealed, accessible piping.
4. Closure: Bronze plug with tapered threads.

C. Downspout Nozzles DN-1:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

2.3 FLASHING MATERIALS

A. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

B. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.

3. Locate cleanouts at minimum intervals of 50 feet <Insert dimension> for piping NPS 4 and smaller and 100 feet for larger piping.

C. Install test tees in vertical conductors and near floor.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

B. Secure flashing into sleeve and specialty clamping ring or device.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 14 23

SECTION 22 14 29 - 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, inside the building, for building storm drainage systems:

1. Submersible sump pumps.
2. Controls.

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. Commissioning Requirements: Provide a comprehensive commissioning plan, clearly demonstrating the system design parameters and identifying the testing procedures. Include individual/agency responsible for performing the tests and the format in which the test results will be presented. The commissioning requirements are covered under Division 01 Sections.

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 01 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.

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.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

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 1 of the manufacturers specified.

2.2 SUBMERSIBLE SUMP PUMPS

A. Manufacturers:

1. Goulds Pumps; ITT Industries.
2. Weil Pump Company, Inc.
3. Weinman Div.; Crane Pumps & Systems.
4. Zoeller Pump

B. Casing: Stainless steel; with stainless-steel inlet strainer, legs that elevate pump to permit flow into impeller, and vertical discharge with companion flange suitable for piping connection.

C. Impeller: Stainless steel or other corrosion-resistant material.

D. Casing and Impeller: Cast-iron casing with metal inlet strainer and brass, bronze, or cast-iron impeller.

E. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings and double-mechanical seals.

F. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection; three-conductor waterproof power cable of length required, and with grounding plug and cable-sealing assembly for connection at pump. Comply with requirements in Division 22 Section "Motors."

1. Moisture-Sensing Probe: Internal moisture sensor with moisture alarm.

G. Pump Discharge Piping: Factory or field fabricated, ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe.

H. Controls:
1. Enclosure: NEMA 250, Type 4X wall-mounted.
2. Switch Type: Mercury-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
3. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

I. Capacity and Characteristics:

1. See schedules on the Drawings.

2.3 SUMP-PUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

1. Material: Fiberglass or Polyethylene.
2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

C. Capacities and Characteristics:

1. Capacity: 159 gal.
2. Diameter: 36 inches.
3. Depth: 36 inches.
4. Inlet No. 1:

a. Drainage Pipe Size: 4” NPS.
b. Bottom of Sump to Centerline: Field verify
c. Type: Hubbed outside.

5. Cover Material: Steel with bituminous coating.
6. Cover Diameter: Not less than outside diameter of basin top flange.
7. Manhole Required in Cover: No.
8. Vent Size: Not required.

2.4 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Flex-Pression, Ltd.
4. Flex-Weld, Inc.
5. Metraflex, Inc.

B. Description: 125-psig minimum working-pressure rating and ends matching pump connection:

1. Bronze Flexible Connectors: Corrugated, bronze inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to tubing.
2. Stainless-Steel Flexible Connectors: Corrugated, stainless-steel inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to tubing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.2 SUMP PUMP INSTALLATION

A. Install sump pumps according to applicable requirements in HI 1.4.

B. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.

C. Set submersible sump pumps in elevator sump pit. Make direct connections to drainage piping.

D. Supports piping so pumps do not support the weight of piping.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 22 Section "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings and specialties.

B. Install piping adjacent to sump pumps to allow service and maintenance.

C. Install discharge piping equal to or greater than size of pump discharge piping. Refer to Division 22 Section "Sanitary Waste and Vent Piping."

1. Install flexible connectors adjacent to pumps in discharge piping.
2. 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 Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves for drainage piping.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section “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 AND TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps. Refer to Division 01 Section "Closeout Procedures."

END OF SECTION 22 14 29

SECTION 22 36 00 – DOMESTIC WATER GEOTHERMAL WATER-SOURCE HEAT 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 types of water-source heat pumps:
   1. Domestic Water.

1.3 SUBMITTALS

A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, 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.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of unit indicated.

E. Product Certificates: For each type of water-source heat pump, signed by product manufacturer.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For water-source heat pumps to include in emergency, operation and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Data: Drawings indicating size, profiles and dimensional requirements of water-source heat pumps and are based on the specific system indicated. Refer to Division 01.
   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.

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. ASHRAE Compliance:
1. ASHRAE 15.

D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 07.

E. Comply with NFPA 70.

F. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.5 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.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water-source heat pumps that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, refrigeration components.
2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER GEOTHERMAL WATER-SOURCE HEAT PUMPS

A. Manufacturer:
1. Colmac Coil Manufacturing, Inc.; model HPW7LS.
2. Alternate manufacturers offering products with similar quality and performance. Contractor shall propose modifications required to the design to use these systems.
a. Florida Heat Pump – Bosch Group.
b. Addison Products.
c. Water Furnace

B. General
1. The heat pump water heater shall be packaged water source equipment, factory assembled and charged. The heat pump shall be suitable for heating potable water and have the capability of producing no less than 71C (160F) water, with heating capacity and C.O.P. as indicated on the drawings.

C. Heat Pump Unit: Unit shall consist of compressor, condenser, evaporator, hot water circulating pump, piping and controls, factory piped and charged. The heat pump shall contain the following components and features:

1. Evaporator: Shall be single-wall brazed plate type constructed with stainless steel plates.
2. Refrigerant: Refrigerant shall be R134a.
3. Expansion Valve: Valves shall be specifically designed for heat pump use with field adjustable superheat feature. Expansion valve shall have MOP (Maximum Operating Pressure) type power element to effectively limit saturated suction temperature to 18°C (65°F).
4. Compressor: Hermetic scroll type by Copeland Corp., suitable for high temperature operation with R134a refrigerant.
5. Compressor Controls: Compressor controls/accessories must include the following:

    a. Suction and Discharge Service Valves.
    b. High and Low Refrigerant Pressure Safety Switches.
    c. Indicator Lights for:

        1) Power On.
        2) Hot Water Demand.
        3) High Pressure Fail.
        4) Low Pressure Fail.

    d. Multi-function Phase Failure Relay.
    e. Crankcase Heater and Relay.

6. Condenser: Stainless steel brazed plate vented double wall type. Single wall condenser construction shall not be allowed. UL Listed and suitable for high temperature operation with potable water.
7. Refrigerant Accessories:

    a. Filter-driers: Non-Replaceable Core Type.
    b. Sight Glass: Moisture Indicating Type.

8. Anti-Short Cycle Control: Units shall be factory wired to allow a maximum of 12 compressor starts per hour to prevent compressor short cycling and allow time for suction and discharge pressures to equalize permitting the compressor to start in an unloaded condition.
9. Hot Water Circulating Pumps: Shall be factory installed in-line all bronze or stainless steel body centrifugal type able to deliver rated flow against the external head shown on the drawings.
10. Source Water Circulating Pumps: Provided under Division 23. Shall have capacity and construction as shown on the drawings. To be approved by the Engineer and the heat pump Manufacturer prior to installation.
11. Controls: The heat pump unit shall be factory wired for fully automatic operation. Safeties shall include compressor motor thermal overload protection, manual reset pressure stats, anti-cycling compressor relays, plus standard items recommended by the equipment manufacturer.
12. Constant Leaving Water Temperature Control: Heat pump shall be factory equipped with electronic temperature control valve (e-TCV) which automatically maintains constant leaving water temperature regardless of entering water temperature. Leaving water

temperature is set by the heat pump operator/user via a field adjustable electronic temperature controller.

2.2 COMPRESSION TANKS

A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

B. Manufacturers:

1. AMTROL Inc.
2. Armstrong Pumps, Inc.
3. Flexcon Industries.
4. Honeywell Sparco.
5. Myers, F. E.; Pentair Pump Group (The).
6. Smith, A. O.; Aqua-Air Div.
7. State Industries, Inc.
8. Taco, Inc.
9. Watts Regulator Co.
10. Wessels Co.

C. Construction:

1. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
2. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
3. Air-Charging Valve: Factory installed.

D. Capacity and Characteristics:

1. See schedules on the Drawings.

2.3 WATER HEATER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of water-source heat pumps.

B. Examine roughing-in for piping and electric installations for water-source heat pumps to verify actual locations of piping connections and electrical conduit before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install commercial water heaters on concrete bases.

B. Concrete base construction requirements are specified in Division 22 Section "Basic Plumbing Materials and Methods."

C. Install 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.

D. Install combination temperature and pressure relief valves in water piping for water heaters without storage. 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.

E. 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 water heaters that do not have tank drains. Refer to Division 22 Section "Plumbing Specialties" for hose-end drain valves.

F. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages" for thermometers.

G. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify or arrange manifolds for balanced water flow through each water heater. Include shutoff valve, thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 22 Section "Valves" for general-duty valves and to Division 22 Section "Meters and Gages" for thermometers.

H. Install water storage tanks on concrete bases, level and plumb, firmly anchored. Arrange so devices needing servicing are accessible.

I. Anchor tank supports and tanks to substrate.

J. Install thermometers and pressure gages on water storage tanks and piping if indicated. Thermometers and pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."

K. Install the following devices on tanks where indicated:

1. Temperature and pressure relief valves.
2. Connections to accessories.

L. After installing tanks with factory finish, inspect finishes and repair damages to finishes.

M. Fill water heaters with water.

1. Charge compression tanks with air.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings and specialties.

B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

D. Connect water piping to water storage tanks with unions or flanges and with shutoff valves. Connect tank drains with shutoff valves and discharge over closest floor drains.

1. General-duty valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

a. Valves NPS 2 (DN 50) and Smaller: Gate or ball.
b. Valves NPS 2-1/2 (DN 65) and Larger: Gate or butterfly.
c. Drain Valves: NPS 3/4 (DN 20) gate or ball valve. Include outlet with, or nipple in outlet with, ASME B1.20.7, 3/4-11.5NH thread for garden-hose service, threaded cap, and chain.

2. Water Piping Connections: Make connections to dissimilar metals with dielectric fittings. Dielectric fittings are specified in Section 221116 "Domestic Water Piping."

E. Ground equipment according to Division 26.

F. Connect wiring according to Division 26.

3.4 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. After installing water-source heat pumps and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to compressor, coils and fans.
3. Inspect internal insulation.
4. Verify that labels are clearly visible.
5. Verify that clearances have been provided for servicing.
6. Verify that controls are connected and operable.
7. Adjust vibration isolators.
8. Start unit according to manufacturer's written instructions.
9. Complete startup sheets and attach copy with Contractor's startup report.
10. Inspect and record performance of interlocks and protective devices; verify sequences.
11. Operate unit for an initial period as recommended or required by manufacturer.
12. Verify sensor calibration.
13. Start system and measure and record the following. All measurements need to be taken as close to the same time as possible as the domestic flow rate is varied to maintain a constant domestic water leaving water temperature.

    a. Domestic water flow rate.
    b. Ground loop water flow rate.
    c. Domestic water entering temperature.
    d. Domestic water leaving temperature.
    e. Ground loop water entering temperature.
    f. Ground loop water leaving temperature.

3.6 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. 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 2 visits to Project during other than normal occupancy hours for this purpose.

3.7 CLEANING

A. After completing installation of exposed, factory-finished water-source heat pumps, inspect exposed finishes and repair damaged finishes.

B. Clean and disinfect potable-water storage tanks.

C. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed, use procedure described in AWWA C652 or as described below:

1. Purge water storage tanks with potable water.
2. Disinfect tanks by one of the following methods:

    a. Fill tanks with water-chlorine solution containing at least 50 ppm (50 mg/L) of chlorine. Isolate tanks and allow to stand for 24 hours.
    b. Fill tanks with water-chlorine solution containing at least 200 ppm (200 mg/L) of chlorine. Isolate tanks and allow to stand for three hours.

3. Flush tanks, after required standing time, with clean, potable water until chlorine is not present in water coming from tank.
4. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination made by authorities having jurisdiction shows evidence of contamination.

D. Prepare written reports for purging and disinfecting activities.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain water-source heat pumps. Refer to Division 01.

END OF SECTION 22 36 00

SECTION 22 42 00 – COMMERCIAL 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. This Section includes the following conventional plumbing fixtures and related components:

1. Faucets for lavatories and sinks.
2. Flushometers.
3. Toilet seats.
4. Protective shielding guards.
5. Fixture supports.
6. Emergency Fixtures
7. Lavatories.
8. Sinks.
9. Service basins.
10. Showers.
11. Urinals.
12. Water closets.

B. Related Documents:

1. Division 01 Section “Construction Waste Management”.
2. Division 01 Section “Sustainable Design Requirements”.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

E. FRP: Fiberglass-reinforced plastic.

F. PMMA: Polymethyl methacrylate (acrylic) plastic.

G. PVC: Polyvinyl chloride plastic.

H. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch- and stain-resistance qualities.

1.4 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment and supports. Indicate materials and finishes, dimensions, construction details and flow-control rates.

B. Shop Drawings: Diagram power, signal and control wiring.

C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through 1 source from a single manufacturer.

1. Exception: If fixtures, faucets or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

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. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: omply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Stainless-Steel Residential Sinks: ASME A112.19.3.
2. Vitreous-China Fixtures: ASME A112.19.2M.
3. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
4. Faucets: ASME A112.18.1.
5. Hose-Connection Vacuum Breakers: ASSE 1011.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
8. NSF Potable-Water Materials: NSF 61.
9. Pipe Threads: ASME B1.20.1.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Supply Fittings: ASME A112.18.1.
12. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Manual-Operation Flushometers: ASSE 1037.
4. Plastic Tubular Fittings: ASTM F 409.
5. Brass Waste Fittings: ASME A112.18.2.
6. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Flexible Water Connectors: ASME A112.18.6.
2. Floor Drains: ASME A112.6.3.
3. Grab Bars: ASTM F 446.
4. Hose-Coupling Threads: ASME B1.20.7.
5. Off-Floor Fixture Supports: ASME A112.6.1M.
6. Pipe Threads: ASME B1.20.1.
7. Plastic Toilet Seats: ANSI Z124.5.
8. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures of unit shell.

b. Faulty operation of controls, blowers, pumps, heaters and timers.
c. Deterioration of metals, metal finishes and other materials beyond normal use.

2. Warranty Period for Commercial Applications: 1 year from date of Substantial Completion.

1.7 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. Faucet Washers and O-Rings: Equal to 10% of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5% of amount of each type and size installed.
3. Flushometer Valve, Repair Kits: Equal to 10% of amount of each type installed, but no fewer than 12 of each type.
4. Toilet Seats: Equal to 5% of amount of each type installed.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

B. Lavatory Faucets LF-1: Manual-type, two handle hot and cold water metering facuet, commercial, solid-brass valve.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. Chicago Faucets.
   b. Delta Faucet Company.
   c. Elkay Manufacturing Co.
   d. Moen Incorporated.
   e. Speakman Company.
   f. T & S Brass and Bronze Works, Inc.
   g. Zurn Industries, LLC; Commercial Brass and Fixtures.

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 fixture receptor.
4. Body Type: Widespread.
5. Body Material: Commercial, solid brass.
6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 0.35 gpm (1.5 L/min.)
8. Duration of Flow Flow: 12 seconds per metering cycle.
9. Mounting Type: Deck, concealed.
10. Valve Handle(s): Knob

11. Spout: Rigid type.
12. Spout Outlet: Aerator.
13. Operation: Metering.
14. Drain: Not part of faucet.

C. Lavatory Faucets LF-2: Manual-type, two-handle mixing, commercial, solid-brass valve.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. Chicago Faucets.
   b. Delta Faucet Company.
   c. Elkay Manufacturing Co.
   d. Moen Incorporated.
   e. Speakman Company.
   f. T & S Brass and Bronze Works, Inc.
   g. Zurn Industries, LLC; Commercial Brass and Fixtures.

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 fixture receptor.
4. Body Type: Widespread.
5. Body Material: Commercial, solid brass.
6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 0.35 gpm (1.5 L/min.).
8. Mounting Type: Deck, concealed.
9. Valve Handle(s): Wrist blade, 4 inches (102 mm).
10. Spout: Rigid type.
11. Spout Outlet: Aerator.
12. Operation: Compression, manual.
13. Drain: Not part of faucet.

2.2 SINK FAUCETS

A. Sink Faucet, SF-1: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Available Manufacturers:
   a. Chicago Faucets, model 540-LD897SWXFCP.
   b. Delta Commercial Brass.
   c. Speakman.
   d. Symmons.
   e. T &S Brass.

2. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
3. Body Material: Cast brass.
4. Finish: Rough chrome plate.
5. Type: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet and pail hook.
6. Mixing Valve: 2-lever handle.
7. Centers: 8”.

8. Mounting: Back/wall, exposed.
9. Handles: Cross, 4 arm.
10. Inlets: NPS 1/2 (DN 15) female shank.
11. Spout: Rigid, cast with wall brace.
12. Spout Outlet: Hose thread.
13. Vacuum Breaker: Required.
14. Operation: Compression, manual.

B. Sink Faucets SF-2: Manual type, two-lever-handle mixing valve.

1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
   a. Bradley Corporation.
   b. Chicago Faucets.
   c. Delta Faucet Company.
   d. Moen Incorporated.
   e. Speakman Company.
   f. T & S Brass and Bronze Works, Inc.
   g. Zurn Industries, LLC; Commercial Brass and Fixtures.

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.
6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 0.5 gpm (2.2 L/min.).
8. Handle(s): Wrist blade, 4 inches (102 mm).
9. Mounting Type: Back/wall, exposed.
10. Spout Type: Rigid gooseneck.
11. Vacuum Breaker: Not required for hose outlet.
12. Spout Outlet: Aerator.

2.3 SHOWER VALVES

A. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for shower materials that will be in contact with potable water.

B. Shower Valve SV-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard America.
   b. Chicago Faucets.
   c. Kohler Co.
   d. Lawler Manufacturing Co., Inc.
   e. Leonard Valve Company.
   f. Moen Incorporated.
   g. Powers; a division of Watts Water Technologies, Inc.
   h. Speakman Company.

i. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.

2. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and shower head.
3. Faucet:
   a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
   b. Body Material: Solid brass.
   c. Finish: Polished chrome plate.
   d. Maximum Flow Rate: 1.25 gpm (5.6 L/min.).
   e. Mounting: Concealed in surface mounted, 18 guag stainless steel that extends to the ceiling and includes a soap dish..
   f. Operation: Single-handle, twist or rotate control.
   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.
4. Supply Connections: NPS 1/2 (DN 15).
5. Shower Head:
   a. Standard: ASME A112.18.1/CSA B125.1.
   b. Type: Fixed, integral with mounting flange.
   c. Shower Head Material: Metallic with chrome-plated finish.
   d. Spray Pattern: Adjustable.
   e. Integral Volume Control: Not required.
   f. Shower-Arm, Flow-Control Fitting: Not required.
   g. Temperature Indicator: Not required.

C. Shower Valve SV-2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard America.
   b. Chicago Faucets.
   c. Kohler Co.
   d. Lawler Manufacturing Co., Inc.
   e. Leonard Valve Company.
   f. Moen Incorporated.
   g. Powers; a division of Watts Water Technologies, Inc.
   h. Speakman Company.
   i. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.
2. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and shower head.
3. Faucet:
   a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
   b. Body Material: Solid brass.
   c. Finish: Polished chrome plate.
   d. Maximum Flow Rate: 1.25 gpm (5.6 L/min.).
   e. Mounting: Concealed in surface mounted, 18 guage stainless steel that extends to the ceiling and includes a soap dish..
   f. Operation: Single-handle, twist or rotate control.
   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.

4. Supply Connections: NPS 1/2 (DN 15).
5. Shower Head:
   a. Standard: ASME A112.18.1/CSA B125.1.
   b. Type: Hand held sprayer with 60" stainless steel braided hose.
   c. Shower Head Material: Metallic with chrome-plated finish.
   d. Spray Pattern: Fixed.
   e. Integral Volume Control: Not required.
   f. Shower-Arm, Flow-Control Fitting: Not required.
   g. Temperature Indicator: Not required.

D. Shower Valve SV-3:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard America.
   b. Chicago Faucets.
   c. Kohler Co.
   d. Lawler Manufacturing Co., Inc.
   e. Leonard Valve Company.
   f. Moen Incorporated.
   g. Powers; a division of Watts Water Technologies, Inc.
   h. Speakman Company.
   i. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.

2. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and shower head.
3. Faucet:
   a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
   b. Body Material: Solid brass.
   c. Finish: Polished chrome plate.
   d. Maximum Flow Rate: 1.25 gpm (5.6 L/min.).
   e. Mounting: Concealed in surface mounted, 18 guage stainless steel that extends to the ceiling and includes a soap dish..
   f. Operation: Single-handle, twist or rotate control.
   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.

4. Supply Connections: NPS 1/2 (DN 15).
5. Shower Head:
   a. Standard: ASME A112.18.1/CSA B125.1..
   b. Shower Head Material: Metallic with chrome-plated finish.
   c. Spray Pattern: Fixed.
   d. Integral Volume Control: Not required.
   e. Shower-Arm, Flow-Control Fitting: Not required.
   f. Temperature Indicator: Not required.

2.4 FLUSHOMETER VALVES

A. Lever-Handle, Diaphragm Flushometer Valves FV-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Coyne & Delany Co.
   b. Gerber Plumbing Fixtures LLC.
   c. Sloan Valve Company.
   d. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig (860 kPa).
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Consumption: 1.6/1.1 gal. (6/4L) per flush.
10. Minimum Inlet: NPS 1 (DN 25).
11. Minimum Outlet: NPS 1-1/4 (DN 32).

B. Lever-Handle, Diaphragm Flushometer Valves FV-2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Coyne & Delany Co.
   b. Gerber Plumbing Fixtures LLC.
   c. Sloan Valve Company.
   d. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig (860 kPa).
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Style: Exposed.
8. Consumption: 0.125 gal. (568 m L).
9. Minimum Inlet: NPS 3/4 (DN 20).
10. Minimum Outlet: NPS 3/4 (DN 20).

2.5 TOILET SEATS

A. Toilet Seat, TS-1: Solid plastic.

1. Available Manufacturers:
   a. Beneke.
   b. Bemis.
   c. Church.

2. Configuration: Open front without cover.
3. Size: Elongated.
4. Class: Standard commercial.
5. Hinge Type: SC, self-sustaining, check.
6. Color: White.

2.6 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Guard, PSG-1: Manufactured, plastic covering for hot- and cold-water supplies and trap and drain piping and complying with ADA requirements.

1. Available Manufacturers:
   a. Truebro.

2.7 FIXTURE SUPPORTS

A. Water-Closet Support, WCS-1: Heavy duty, water-closet combination carrier designed for accessible mounting height. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate and feet for installation in wide pipe space.

1. Available Manufacturers:
   a. Josam Co.
   b. Smith, Jay R. Mfg. Co.
   c. Tyler Pipe, Wde Div.
   d. Watts Industries, Inc.; Enpoco, Inc. Div.
   e. Watts Industries, Inc.; Watts Drainage Products Div.
   f. Zurn Specifications Drainage Operation.

B. Off-Floor, Plumbing Fixture Supports: ASME A112.6.1M, water-cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Available Manufacturers:
   a. Josam Co.
   b. Smith, Jay R. Mfg. Co.
   c. Tyler Pipe; Wade Div.
   d. Watts Industries, Inc.; Enpoco, Inc. Div.
   e. Watts Industries, Inc.; Watts Drainage Products Div.
   f. Zurn Specifications Drainage Operation.

2. Type I: Hanger-type carrier with 2 vertical uprights.
3. Type II: Bilevel, hanger-type carrier with 3 vertical uprights.
4. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

2.8 WATER-TEMPERING EQUIPMENT

A. Hot- and Cold-Water, Water-Tempering Equipment

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. Acorn Safety; a division of Acorn Engineering Company.
   b. Armstrong International, Inc.
   c. Bradley Corporation.
   d. Encon Safety Products.
   e. Guardian Equipment Co.
   f. Haws Corporation.
   g. Lawler Manufacturing Co., Inc.
   h. Leonard Valve Company.
   i. Powers; a division of Watts Water Technologies, Inc.
   j. Speakman Company.

2. Description: Factory-fabricated equipment with thermostatic mixing valve.
   a. Thermostatic Mixing Valve: Designed to provide [85 deg F (29 deg C)] <Insert temperature> tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus [5 deg F (3 deg C)] <Insert temperature> throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
   b. Supply Connections: For hot and cold water.

2.9 EYEWASH

A. Accessible, Wall-Mounted, Plumbed Eyewash Units, EW-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. Acorn Safety; a division of Acorn Engineering Company.
   b. Bradley Corporation.
   c. Encon Safety Products.
   d. Guardian Equipment Co.
   e. Haws Corporation.
   f. Speakman Company.

2. Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
3. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
4. Control-Valve Actuator: Paddle.
5. Spray-Head Assembly: Two receptor-mounted spray heads.
6. Receptor: Chrome-plated brass or stainless-steel bowl.
7. Drain Piping: NPS 1-1/4 (DN 32) minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.
8. Mounting: Wall bracket.
9. Special Construction: Comply with ICC/ANSI A117.1.

2.10 EMERGENCY SHOWER

A. Accessible, Plumbed Emergency Shower with Eyewash Combination Units, ESH-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. Acorn Safety; a division of Acorn Engineering Company.
   b. Bradley Corporation.
   c. Encon Safety Products.
   d. Guardian Equipment Co.
   e. Haws Corporation.
   f. WaterSaver Faucet Co.

2. Piping:
   a. Material: Galvanized steel.
   b. Unit Supply NPS 1-1/2 (DN 40).
   c. Unit Drain: Outlet at back or side near bottom.

3. Shower:
   a. Capacity: Not less than 20 gpm (76 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1 (DN 25) with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Pull rod.
   d. Shower Head: 8-inch- (200-mm-) minimum diameter, chrome-plated brass or stainless steel.
   e. Mounting: Pedestal.

4. Eyewash Unit:
   a. Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1/2 (DN 15) with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Paddle.
   d. Spray-Head Assembly: Two receptor-mounted spray heads.
   e. Receptor: Chrome-plated brass or stainless-steel bowl.
   f. Mounting: Attached shower pedestal.

2.11 ENAMELED, CAST-IRON, WALL-MOUNTED LAVATORIES

A. Lavatory L-1: Rectangular, enameled, cast iron, wall mounted.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard America.
   b. Kohler Co.
   c. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Fixture:
   a. Standard: ASME A112.19.1/CSA B45.2.
   b. Type: Straight-front apron with straight back.
   c. Nominal Size: Rectangular, 19 by 17 inches (483 by 432 mm).

d. Faucet-Hole Punching: Three holes, 4-inch (102-mm) centers.
e. Faucet-Hole Location: Top.
f. Color: White.
g. Mounting Material: Wall bracket.

3. Faucet: LF-1.
4. Support: ASME A112.6.1M, Type III, lavatory carrier. Include rectangular, steel uprights.

B. Lavatory L-2: Rectangular, enameled, cast iron, wall mounted.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard America.
b. Kohler Co.
c. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Fixture:
a. Standard: ASME A112.19.1/CSA B45.2.
b. Type: Straight-front apron with straight back.
c. Nominal Size: Rectangular, 19 by 17 inches (483 by 432 mm).
d. Faucet-Hole Punching: Three holes, 4-inch (102-mm) centers.
e. Faucet-Hole Location: Top.
f. Color: White.
g. Mounting Material: Wall bracket.

3. Faucet: LF-1.
4. Support: ASME A112.6.1M, Type III, lavatory carrier. Include rectangular, steel uprights.

C. Lavatory L-3: Rectangular, enameled, cast iron, wall mounted.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard America.
b. Kohler Co.
c. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Fixture:
a. Standard: ASME A112.19.1/CSA B45.2.
b. Type: Straight-front apron with straight back.
c. Nominal Size: Rectangular, 19 by 17 inches (483 by 432 mm).
d. Faucet-Hole Punching: Three holes, 4-inch (102-mm) centers.
e. Faucet-Hole Location: Top.
f. Color: White.
g. Mounting Material: Wall bracket.

3. Faucet: LF-2.
4. Support: ASME A112.6.1M, Type III, lavatory carrier. Include rectangular, steel uprights.

2.12 SERVICE BASINS

A. Service Basins MR-1: 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: Rectangular.
   c. Nominal Size: 24 by 36 inches (610 by 915 mm).
   d. Height: 10 inches (255 mm).
   e. Rim Guard: On front top surfaces.
   f. Color: Not applicable.
   g. Drain: Grid with NPS 2 (DN 50) outlet.

3. Mounting: On floor and flush to wall.
4. Faucet: SF-1.

2.13 SHOWERS

A. Student Shower SH-1: Field fabricated tiled shower basin and walls.
   1. General: Tiled shower floor and walls specified under other sections.
   2. Outlet: Provide 2" floor drain FD-2, where shown on the drawings.
   3. Shower Valve: Provide shower valve SV-1.

B. Accessible Student Shower SH-2: Field fabricated tiled shower basin and walls.
   1. General: Tiled shower floor and walls specified under other sections.
   2. Outlet: Provide 2" floor drain FD-2, where shown on the drawings.
   3. Shower Valve: SV-2.

C. Staff Shower SH-3: Field fabricated tiled shower basin and walls.
   1. General: Tiled shower floor and walls specified under other sections.
   2. Outlet: Provide 2" floor drain FD-2, where shown on the drawings.
   3. Shower Valve: SV-2.

2.14 SINKS

A. Single Bowl Sink S-1: One bowl, counter mounted, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elkay Manufacturing Co.
   b. Just Manufacturing.
   c. Kohler Co.

2. Fixture:
   a. Standard: ASME A112.19.3/CSA B45.4 for stainless-steel kitchen sinks.
   b. Overall Dimensions: <Insert dimensions>.
   c. Metal Thickness: 0.050 inch (1.3 mm).
   d. Bowl:

      1) Dimensions: <Insert dimensions>.
      2) Drain: 3-1/2-inch (89-mm) crumb cup.

         a) Location: Rear center..

3. Faucet: SF-3.
4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
5. Waste Fittings: Comply with requirements in "Waste Fittings" Article, except include continuous waste for multibowl sinks.

B. Double Bowl Sink S-2: Two bowl, counter mounted, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elkay Manufacturing Co.
   b. Just Manufacturing.
   c. Kohler Co.

2. Fixture:
   a. Standard: ASME A112.19.3/CSA B45.4 for stainless-steel kitchen sinks.
   b. Overall Dimensions: <Insert dimensions>.
   c. Metal Thickness: 0.050 inch (1.3 mm).
   d. Left Bowl:

      1) Dimensions: <Insert dimensions>.
      2) Drain: 3-1/2-inch (89-mm) crumb cup.

         a) Location: Rear center.
   e. Right Bowl:

      1) Dimensions: <Insert dimensions>.
      2) Drain: 3-1/2-inch (89-mm) crumb cup.

         a) Location: Rear center.

3. Faucet: SF-3.
4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
5. Waste Fittings: Comply with requirements in "Waste Fittings" Article, except include continuous waste for multibowl sinks.

C. Classroom Sinks S-3: One bowl counter mounted, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elkay Manufacturing Co.
   b. Just Manufacturing.
   c. Kohler Co.

2. Fixture:
   a. Standard: ASME A112.19.3/CSA B45.4 for stainless-steel kitchen sinks.
   b. Overall Dimensions: <Insert dimensions>.
   c. Metal Thickness: 0.050 inch (1.3 mm).
   d. Bowl:

      1) Dimensions: <Insert dimensions>.
      2) Drain: 3-1/2-inch (89-mm) crumb cup.

         a) Location: Rear center.

3. Faucet: SF-3.
4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
5. Waste Fittings: Comply with requirements in "Waste Fittings" Article, except include continuous waste for multibowl sinks.

D. Science Classroom Sinks S-4: One bowl, counter mounted, resin..

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Fixture:
   a. Standard: ASME A112.19.3/CSA B45.4 for stainless-steel kitchen sinks.

3. Faucet: SF-4.
4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
5. Waste Fittings: Comply with requirements in "Waste Fittings" Article, except include continuous waste for multibowl sinks.

E. Science Classroom Sinks S-5: One bowl, counter mounted, resin.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Fixture:
   a. Standard: ASME A112.19.3/CSA B45.4 for stainless-steel kitchen sinks.
   b. Overall Dimensions: <Insert dimensions>.

3. Faucet: SF-4.
4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
5. Waste Fittings: Comply with requirements in "Waste Fittings" Article, except include continuous waste for multibowl sinks.

F. Art Room Sinks S-6: One bowl, counter mounted, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elkay Manufacturing Co.
   b. Just Manufacturing.
   c. Kohler Co.

2. Fixture:
   a. Standard: ASME A112.19.3/CSA B45.4 for stainless-steel kitchen sinks.
   b. Overall Dimensions: <Insert dimensions>.
   c. Metal Thickness: 0.050 inch (1.3 mm).
   d. Bowl:

      1) Dimensions: <Insert dimensions>.
      2) Drain: 3-1/2-inch (89-mm) crumb cup.

         a) Location: Rear center.

3. Faucet: SF-3.
4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
5. Waste Fittings: Comply with requirements in "Waste Fittings" Article, except include continuous waste for multibowl sinks.

G. Cleanup Sinks S-7: Stainless steel, wall hung.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Advance Tabco.
   b. Elkay Manufacturing Co.
   c. Just Manufacturing.

2. Fixture:

   a. Standard: ASME A112.19.3/CSA B45.4.
   b. Type: With backsplash.
   c. Number of Compartments: One.
   d. Overall Dimensions: 48” x 20”.
   e. Metal Thickness: 0.063 inch (1.6 mm).
   f. Compartment:

      1) Dimensions: 45” x 16 ½”.
      2) Drain: Grid with NPS 1-1/2 (DN 40) tailpiece and twist drain.
      3) Drain Location: Centered in compartment.

3. Supports: Adjustable-length steel legs.
4. Faucet(s): SF-2.

   a. Number Required: Two.
   b. Mounting: On backsplash.

5. Supply Fittings: Comply with requirements in "Supply Fittings" Article.

6. Waste Fittings: Comply with requirements in "Waste Fittings" Article, except include floor mounted solids interceptor on drain in lieu of trap.

2.15 WALL-HUNG URINALS

A. Urinals U-1: Wall hung, back outlet, washout.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard America.
   b. Crane Plumbing, L.L.C.
   c. Ferguson Enterprises, Inc.; ProFlo Brand.
   d. Gerber Plumbing Fixtures LLC.
   e. Kohler Co.
   f. Mansfield Plumbing Products LLC.
   g. TOTO USA, INC.
   h. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Fixture:
   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
   b. Material: Vitreous china.
   c. Type: Washout with extended shields.
   d. Trap: Integral
   e. Water Consumption: [Water saving] [Low].
   f. Spud Size and Location: NPS 3/4 (DN 20), top.
   g. Outlet Size and Location: NPS 2 (DN 50), back.
   h. Color: White

3. Flushometer Valve: FV-2
4. Waste Fitting:
   a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
   b. Size: NPS 2 (DN 50).

5. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.

B. Urinals U-2: Accessible, wall hung, back outlet, washout.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard America.
   b. Crane Plumbing, L.L.C.
   c. Ferguson Enterprises, Inc.; ProFlo Brand.
   d. Gerber Plumbing Fixtures LLC.
   e. Kohler Co.
   f. Mansfield Plumbing Products LLC.
   g. TOTO USA, INC.

h. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Fixture:
   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
   b. Material: Vitreous china.
   c. Type: Washout with extended shields.
   d. Trap: Integral
   e. Water Consumption: [Water saving] [Low].
   f. Spud Size and Location: NPS 3/4 (DN 20), top.
   g. Outlet Size and Location: NPS 2 (DN 50), back.
   h. Color: White

3. Flushometer Valve: FV-2
4. Waste Fitting:
   a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
   b. Size: NPS 2 (DN 50).

5. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.

2.16 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

A. Water Closets WC-1: Floor mounted, bottom outlet, top spud.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard America.
   b. Crane Plumbing, L.L.C.
   c. Gerber Plumbing Fixtures LLC.
   d. Kohler Co.
   e. Mansfield Plumbing Products LLC.
   f. TOTO USA, INC.
   g. Zurn Industries, LLC; Commercial Brass and Fixtures.

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, complying with ICC/ANSI A117.1].
   f. Rim Contour: Elongated.
   g. Consumption: 1.6/1.1 gal. (6/4L) per flush.
   h. Spud Size and Location: NPS 1-1/2 (DN 40); top.
   i. Color: White.

3. Bowl-to-Drain Connecting Fitting: [ASTM A 1045 or]ASME A112.4.3.
4. Flushometer Valve: FV-1.
5. Toilet Seat: TS-1.

B. Water Closets WC-2: Accessible, floor mounted, bottom outlet, top spud.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard America.
   b. Crane Plumbing, L.L.C.
   c. Ferguson Enterprises, Inc.; ProFlo Brand.
   d. Gerber Plumbing Fixtures LLC.
   e. Kohler Co.
   f. Mansfield Plumbing Products LLC.
   g. TOTO USA, INC.
   h. Zurn Industries, LLC; Commercial Brass and Fixtures.

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: Handicapped/elderly, complying with ICC/ANSI A117.1].
   f. Rim Contour: Elongated.
   g. Consumption: 1.6/1.1 gal. (6/4L) per flush.
   h. Spud Size and Location: NPS 1-1/2 (DN 40); top.
   i. Color: White.

3. Bowl-to-Drain Connecting Fitting: [ASTM A 1045 or]ASME A112.4.3.
4. Flushometer Valve: FV-1.
5. Toilet Seat: TS-1.

2.17 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

F. Risers:

1. NPS 3/8 (DN 10).
2. Chrome-plated, soft-copper flexible tube or ASME A112.18.6, braided- -stainless-steel, flexible hose riser.

2.18 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Lavatory Drain: Grid type with NPS 1-1/4 (DN 32) offset and straight tailpiece.

C. Drain: Grid type with NPS 1-1/2 (DN 40) offset tailpiece for accessible stainless steel and resin sinks.

D. Drain: Grid type with NPS 1-1/2 (DN 40) straight tailpiece for standard stainless steel and resin sinks.

E. Traps:

1. Lavatory Size: NPS 1-1/4 (DN 32).
   a. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall; and chrome-plated, brass or steel wall flange.
2. Sink Size: NPS 1-1/2 (DN 40) for stainless steel and resin sinks.].
   a. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall and chrome-plated-brass or -steel wall flange.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT

A. The Contractor, subcontractors and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Assemble plumbing fixtures, trim, fitting, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General Duty Valves for Plumbing Piping."

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install toilet seats on water closets.

N. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

O. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

P. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

Q. Install shower flow-control fittings with specified maximum flow rates in shower arms.

R. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.

2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

S. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Basic Plumbing Materials and Methods."

T. Set shower and service basins in leveling bed of cement grout. Grout is specified in Division 22 Section "Basic Plumbing Materials and Methods."

U. Seal joints between fixtures and walls, floors and countertops using sanitary-type, 1-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

V. Install control modules for sensor operated lavatories as close to underside of counter tops as possible.

3.4 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, gate, or globe 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 Section 220523 "General-Duty Valves for Plumbing Piping."

1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.

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 221116 "Domestic Water Piping."

F. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

G. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings and specialties.

B. Connect fixtures with water supplies, stops and risers, and with traps, soil, waste and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

E. Sensor operated fixtures:

1. Furnish and install low voltage transformer and wiring to fixtures.
2. Furnish and install recessed junction boxes where required for installation of controls.
3. 120 volt wiring by Division 26 Contractor.

3.6 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.7 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

3.8 CLEANING

A. Clean fixtures, faucets and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets and fittings, inspect exposed finishes and repair damaged finishes.

3.9 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 00

SECTION 22 47 16 - PRESSURE WATER COOLERS

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 pressure water coolers and related components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pressure water cooler.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For pressure water coolers 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. Filter Cartridges: No fewer than one of each type and size indicated.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

A. Bi-Level Water Cooler, EWC-1:

1. Manufacturers: Subject to compliance with requirements, provide products by 1 of the following:

a. Elkay Manufacturing Co.; EZSTL8.
b. Halsey Taylor.
c. Haws Corporation.
d. Oasis Corporation.
e. Sunroc Corp.

2. Description: ARI 1010, Accessible, bilevel, vandal resistant, pressure with bubbler, recessed water cooler.

a. Cabinet: All stainless steel.
b. Bubbler: Dual with adjustable stream regulator, 1 located on each deck.
c. Control: Push bar on front and sides.
d. Supply: NPS 3/8 with ball, gate, or globe valve.
e. Filter: Not required. Supplied from central filtration system.
f. Drain: Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.2.
g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank and adjustable thermostat.

1) Capacity: 8 gph of 50°F cooled water from 80°F inlet water and 90°F ambient air temperatures.
2) Electrical Characteristics: 325 watts; 120-V ac; single phase; 60 Hz.

h. Ventilation Grille: Stainless steel, located on side of fountain.
i. Support: ASME A112.6.1M, Type I water-cooler carrier.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. Set freestanding pressure water coolers on floor.

C. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

D. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.

E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "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 221116 "Domestic Water Piping."

C. Install ball, gate, or globe shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust pressure water-cooler temperature settings.

3.5 CLEANING

A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 47 16

SECTION 23 00 00 - MECHANICAL GENERAL PROVISIONS

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. Permits, Fees and Notices.
2. Applicable Publications and Standards.
3. Code Compliance.
4. Scope of Work.
5. Intent of Drawings and Specifications.
6. Quality Assurance.
7. Submittals.
8. Product Requirements, Equals and Substitutions.
9. Manufacturers Instructions.
10. Transportation and Handling.
11. Storage and Protection.
12. Cutting and Patching.
13. Cleaning Up/Removal of Debris.
14. Starting of Mechanical Systems.
15. Operation and Maintenance Manuals.
16. Training of Owners Operators.
17. Commissioning.
18. Guarantee of Work.

19. System Testing.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 ARTICLES

A. Permits, Fees and Notices:

1. Comply with the General Conditions of the contract.

B. Applicable Publications and Standards:

1. Publications and Standards listed in each Section form a part of that Section to the extent referenced.

2. When a publication or standard is specified by reference, comply with all requirements of that publication or standard, except when requirements are modified by the Contract Documents, or applicable codes establish stricter standards.

3. The Publication or Standard shall be the edition or revision in effect as of the bid date, except when a specific date is listed.

C. Code Compliance:

1. Applicable codes listed as part of the contract documents.

D. Scope of Work:

1. The work to be performed under this Division consists of the satisfactory completion of all HEATING, VENTILATING, and AIR CONDITIONING as indicated in the Contract Documents.

E. Intent of Drawings and Specifications:

1. The intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship, and to provide operable mechanical systems complete in every respect.

2. The drawings are diagrammatic, intending to show general arrangement, capacity and location of system components, and are not intended to be rigid in detail. Final placement of equipment, other system components, and coordination of all related trades shall be the contractor’s responsibility.

3. Due to the small scale of the drawings, and to unforeseen job conditions, all required offsets and fittings may not be shown but shall be provided at no additional cost.

4. In the event of a conflict, the Owner's Representative shall render an interpretation in accordance with the General Conditions.

F. Quality Assurance:

1. Material furnished under this Division shall be standard catalogued products of recognized manufacturers regularly engaged in the production of such material and shall be of the latest design.

2. Materials shall be the best of their respective kinds. Materials shall be new except where the documents permit reuse of certain existing materials.

3. All items necessary for the completion of the work and the successful operation of a product or system shall be provided even though not fully specified or indicated on the drawings.

4. Qualified, experienced personnel specifically trained in their respective field shall perform all work.

5. All work of this Division shall be carefully interfaced with the work of other Divisions to assure a complete, functioning system or systems.

G. Submittals:

1. In addition to all other submittal requirements elsewhere in the contract documents, the contractor shall comply with the following.

2. Submittal for approval shall be required only on those items specifically requested in the specification section that applies.

3. For products and equipment that do not require a submittal for approval, submit a separate letter for each specification section certifying that all products and equipment shall be provided in compliance with the Contract Documents.

4. Submittal data shall be presented in a clear, concise and thorough manner and referenced to the applicable specification section. Submittal data shall note the applicable specification section, page(s), and paragraph number(s).
   a. Where applicable, data shall be identified by reference to drawing sheet, drawing detail, schedule or room number, equipment or unit number as shown on Contract Drawings.

5. Product data and performance data shall be prepared as follows:
   a. Clearly mark each submitted copy to identify pertinent products or models, delete or strikethrough all non-pertinent data.
   b. Show performance characteristics and capacities.
   c. Show dimensions and clearances required.
   d. Show wiring and/or piping diagrams and control schematics.
   e. Clearly identify and list in detail any deviation in the submittals from the requirements of the Contract Documents.
   f. Include installation requirements.

6. Manufacturer's standard schematic drawings and diagrams:
   a. Modify drawings and diagrams to delete or strikethrough information that is not applicable to the work of this project.
   b. Supplement standard information to provide information specifically applicable to the work of this project.

7. Letter of Certification:
   a. Where a submittal is not required, provide a letter certifying that the work shall be completed in strict accordance with the specified requirements. In the event the contractor wishes to alter the requirements of the specification for whatever reason, this should be clearly explained in the Letter of Certification noting that this alteration may require additional submittal requirements.

8. Schedules:
   a. Where schedules are called for, submit schedule indicating which products shall be used and to what extent categorized by system, location, size, etc.

9. Samples, where requested, shall be of sufficient size and quantity to clearly illustrate:
   a. Functional characteristics of the product, with integral related parts and attachment devices.
   b. Full range of color, texture and pattern.

10. The Contractor shall:
    a. Review Submittals, Product Data, Letters of Certification, and Samples prior to submission.
    b. Determine and verify:
       1) Field measurements.
       2) Field construction criteria.
       3) Catalog numbers and similar data.
       4) Conformance and compliance with specifications.
       5) All submittals have been properly interfaced with the requirements of this and other Divisions of work so as to assure a complete and fully functional system in accordance with the Contract Documents.
    c. Do not release equipment for shipment, begin fabrication or work on any item that requires submittal for approval until return of submittal with Owner's Representative approval.
    d. Make submittals promptly, and in such sequence as to cause no delay in the work or in the work of any other contractor.

11. Submittals shall contain:
    a. The date of submission and all resubmission requirements for any previous submissions.
    b. The Project title and number.
    c. Contract identification.
    d. The names and phone numbers including personal contact of:
       1) Contractor.
       2) Supplier.
       3) Manufacturer.
    e. Identification of the product, with the specification section number and contract document description clearly indicated.
    f. Field dimensions, clearly identified as such.

g. Relation to adjacent or critical features of the work or materials.
h. Identification of deviations from Contract Documents.
i. Identification of revisions on resubmittals.
j. Contractor's stamp, initialed or signed, certifying to review of submittal, verification of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the work and of Contract Documents.
k. Each submittal shall be limited to a single specification section. Submittals shall not be grouped with other sections in common binders or under common control sheets. Each submittal shall have a cover/control sheet containing the information listed above and have a minimum of 8-inch x 3-inch clear space for the General Contractors, Engineers and Architects review stamps.
l. Submittals that do not comply with these requirements may be returned with no action taken at the reviewer's discretion.

12. The Engineer shall:
    a. Review the submittal for general compliance with the Contract Documents. The contractor shall be responsible for quantities, dimensions, placement of the product, and coordination with all other trades, maintain service clearance, function and compliance with the written installation instructions.

13. Resubmission requirements for "as specified" products.
    a. Make any corrections or changes in the submittals required by the Owner's Representative and resubmit until approved.
    b. A submittal shall only be reviewed a maximum of three times. If upon the third submission an approved action cannot be rendered, the contractor shall supply the basis of design product and bear all costs incurred by the Owner's Representative during the review process until an approved submittal is achieved.

14. The Contractor shall maintain one copy of all approved submittal data in a job site file.

H. LEED Submittal:

1. Product Data for Credit MR 4.1 and MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
    a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and MR 5.2: For products regionally manufactured materials.
    a. Identify each regionally manufactured material, including its source and cost.
    b. Identify each regionally extracted and manufactured material, including its source and cost.

I. Manufacturer's Instructions:

1. Installation of work shall comply with manufacturer's printed instructions.

2. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with Owner's Representative for clarification. Do not proceed with work without clear instructions.

J. Transportation and Handling:

1. Comply with General Conditions and requirements of each technical specification section.

K. Storage and Protection:

1. Store products in accord with manufacturer's instructions, with seals and labels intact and legible.

2. Store products to prevent damage by the elements. Space conditions and temperature shall be controlled as required to prevent condensation and metal corrosion and/or damage to electrical or electronic parts that are the result of condensation.

3. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration.

4. Provide protection as necessary to prevent damage after installation.

5. Products which suffer damage due to improper storage shall not be installed and if found in place, shall be removed and replaced at the contractors expense.

L. Cleaning Up/Removal of Debris:

1. Maintain a clean work area. Construction debris shall be removed daily from all newly erected work.

M. Starting of Mechanical Systems:

1. Provide material and labor to perform start-up of each item of equipment and system prior to beginning of test, adjust and balance procedures.

2. Provide labor to assist the Owner's Representative in acceptance review.

3. Provide point-by-point system checkout. Submit results in tabulated form by system and component. Include this data as part of Operation and Maintenance Manuals.

4. Provide information and assistance and cooperate with test, adjust, and balance services.

5. Comply strictly with manufacturer's recommended procedures in starting up mechanical systems.

6. Provide such periodic continuing adjustment services as necessary to ensure proper functioning of mechanical systems until acceptance and up to 1 full year after date of substantial completion.

N. Operation and Maintenance (O & M) Manuals:

1. Format: 3-inch thick, 8½ x 11-inch loose-leaf binders. Use as many as required. Do not overload binders.

2. Content:
    a. Cover sheet.
    b. Table of Contents
    c. Each major heading in the table of contents shall have a large distinctive, clearly marked, non-erasable, plastic encased tab.
    d. Operation and Maintenance Instructions:
        1) These shall be the written manufacturer's data edited to omit references to products or data not applicable to this installation.
    e. Parts List:
        1) These shall be edited to omit reference to items that do not apply to this installation.
    f. Equipment Supplier:
        1) This section shall include the name, address and telephone number of the manufacturer's agent and/or service agency supplying, installing and starting up the equipment.
    g. Special Operating Instructions:
        1) This section shall include condensed instructions for start-up, shutdown, emergency operation, safety precautions and troubleshooting suggestions. Where control is clearly covered in controls description, it shall not be duplicated here.
    h. Preventative Maintenance Instructions:
        1) This section shall include excerpts from the manufacturer's written instructions on weekly, monthly, quarterly, annual, etc. maintenance recommendations and/or requirements. The mechanical contractor shall prepare this summary with help from the equipment supplier. The engineer, prior to turning over to the Owner, shall review the prepared preventative maintenance instructions.

O. System Testing:

1. Provide all necessary labor, materials and equipment to successfully complete all system testing necessary for building occupancy and Owner acceptance.

2. Provide all necessary labor, materials and equipment to assist contractors of other Divisions to complete system testing necessary for building occupancy and Owner acceptance, wherever an inter-relationship between this Division and the work of other Divisions exists.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

END OF SECTION 23 00 00

SECTION 23 01 00 - BASIC MECHANICAL MATERIALS AND METHODS

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 materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Mechanical demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”
2. Division 01 Section "LEED Requirements" for additional LEED 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 and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

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. The term "furnish", when used separately, shall mean to "obtain and deliver on the job, for installation by the indicated Trade Contractor".

G. The term "install", when used separately, shall mean to "install in full operating condition equipment supplied to this Contractor by other Trade Contractors".

H. The term "provide" shall mean to "furnish and install".

I. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.

2. CPVC: Chlorinated polyvinyl chloride plastic.

3. PE: Polyethylene plastic.

4. PVC: Polyvinyl chloride plastic.

J. 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. Transition fittings.

2. Dielectric fittings.

3. Escutcheons.

B. Welding certificates.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 and MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and MR 5.2: For products regionally manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

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. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 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.

1.7 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 Division 8 Section "Access Doors and Frames."

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 the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. 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. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is 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 thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. 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.

G. 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 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Manufacturers:
   a. Cascade Waterworks Mfg. Co.
   b. Dresser Industries, Inc.; DMD Div.
   c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
   d. JCM Industries.
   e. Smith-Blair, Inc.
   f. Viking Johnson.

2. Aboveground Pressure Piping: Pipe fitting.

B. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Manufacturers:
   a. Cascade Waterworks Mfg. Co.
   b. Fernco, Inc.
   c. Mission Rubber Company.
   d. Plastic Oddities, Inc.

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.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Manufacturers:
   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Eclipse, Inc.
   d. Epco Sales, Inc.
   e. Hart Industries, International, Inc.
   f. Watts Industries, Inc.; Water Products Div.

g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-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.

E. 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- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
   a. Calpico, Inc.
   b. Lochinvar Corp.

G. Dielectric Nipples: 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. Perfection Corp.
   b. Precision Plumbing Products, Inc.
   c. Sioux Chief Manufacturing Co., Inc.
   d. Victaulic Co. of America.

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.

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: Stainless steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 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. 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. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. One-Piece, Floor-Plate Type: Cast-iron floor plate.

G. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 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, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 MECHANICAL DEMOLITION

A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove mechanical 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 and cap or plug piping with same or compatible piping material.

3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

5. Equipment to Be Removed: Disconnect and cap services and remove equipment.

6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

7. 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.

3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 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 on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. 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.

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 escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:
    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Insulated Piping: One-piece, stamped-steel type with spring clips.
    c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
    d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    f. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
    g. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:
    a. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.

b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
c. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
d. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
e. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
f. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. 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 wet areas 2 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. 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 smaller than NPS 6.
   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
   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 Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
      1) Seal space outside of sleeve fittings with grout.

4. 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. Refer to Division 7 Section "Joint Sealants" for materials and installation.

Q. 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.

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 Division 7 Section "Through-Penetration Firestop Systems" 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.

3.4 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.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.6 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.

D. Install equipment to allow right of way for piping installed at required slope.

3.7 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 9 Section.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 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 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 Division 3 Section "Cast-in-Place Concrete."

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.10 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.

END OF SECTION 23 01 00

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC 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.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. 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.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.

2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. 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.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed 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:

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. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.

3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.

2. Split phase.

3. Capacitor start, inductor run.

4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. 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.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

END OF SECTION 23 05 13

SECTION 23 05 16 - EXPANSION FITTINGS AND LOOPS FOR HVAC 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:

1. Expansion-compensator packless expansion joints.

2. Flexible-hose packless expansion joints.

3. Metal-bellows packless expansion joints.

4. Rubber packless expansion joints.

5. Pipe loops and swing connections.

6. Alignment guides and anchors.

1.3 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of expansion joint, from manufacturer.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 PACKLESS EXPANSION JOINTS

A. Metal, Expansion-Compensator Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amber / Booth
   b. Dunlop
   c. Mason Industries
   d. Metraflex

2. Minimum Pressure Rating: 150 psig unless otherwise indicated.

3. Configuration for Copper Tubing: Two-ply, phosphor-bronze bellows with copper pipe ends.
   a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
   b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.

4. Configuration for Steel Piping: Two-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.
   a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
   b. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Weld.

B. Rubber, Expansion-Compensator Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amber / Booth
   b. Dunlop
   c. Mason Industries
   d. Metraflex

2. Material: Twin reinforced-rubber spheres with external restraining cables.

3. Minimum Pressure Rating: 150 psig at 170 deg F unless otherwise indicated.

4. End Connections for NPS 2 and Smaller: Threaded.

C. Flexible-Hose Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amber / Booth
   b. Dunlop
   c. Mason Industries
   d. Metraflex

2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.

3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.

4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
   a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.

5. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
   a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.

6. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with weld end connections.
   a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.

7. Expansion Joints for Steel Piping NPS 8 to NPS 12: Carbon-steel fittings with weld end connections.

   a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.

D. Metal-Bellows Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amber / Booth
   b. Dunlop
   c. Mason Industries
   d. Metraflex

2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

3. Type: Circular, corrugated bellows with external tie rods.

4. Minimum Pressure Rating: 150 psig unless otherwise indicated.

5. Configuration: Single joint with base and double joint with base class(es) unless otherwise indicated.

6. Expansion Joints for Copper Tubing: Single- or multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
   a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
   b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint or threaded.
   c. End Connections for Copper Tubing NPS 5 and Larger: Flanged.

7. Expansion Joints for Steel Piping: Single- or multi-ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.
   a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
   b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Weld.

E. Rubber Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amber / Booth
   b. Dunlop
   c. Mason Industries
   d. Metraflex

2. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

3. Material: Fabric-reinforced rubber complying with FSA-NMEJ-703.

4. Arch Type: Single or multiple arches.

5. Spherical Type: Single or multiple spheres.

6. Minimum Pressure Rating for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.

7. Minimum Pressure Rating for NPS 5 and NPS 6: 140 psig at 200 deg F.

8. Minimum Pressure Rating for NPS 8 to NPS 12: 140 psig at 180 deg F.

9. Material for Water: EPDM.

10. End Connections: Full-faced, integral steel flanges with steel retaining rings.

2.2 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Adsco Manufacturing LLC.
   b. Advanced Thermal Systems, Inc.
   c. Flex-Hose Co., Inc.
   d. Flexicraft Industries.
   e. Flex-Weld, Inc.
   f. Hyspan Precision Products, Inc.
   g. Metraflex, Inc.
   h. Senior Flexonics Pathway.
   i. Unisource Manufacturing, Inc.
   j. U.S. Bellows, Inc.

2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.

2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.

3. Washers: ASTM F 844, steel, plain, flat washers.

4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
   a. Stud: Threaded, zinc-coated carbon steel.
   b. Expansion Plug: Zinc-coated steel.
   c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
   a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
   b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
   c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 EXPANSION-JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

C. Install rubber packless expansion joints according to FSA-NMEJ-702.

3.3 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.4 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.

2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 23 05 16

SECTION 23 05 17 - SLEEVES AND SLEEVE SEALS FOR HVAC 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:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal fittings.
4. Grout.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

PART 2 - PRODUCTS

2.1 SLEEVES

A. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

B. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Smith, Jay R. Mfg. Co.

2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Presealed Systems.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.

2. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."

3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.

4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.4 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.5 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

2. Exterior Concrete Walls below Grade:

   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 23 05 17

SECTION 23 05 18 - ESCUTCHEONS FOR HVAC 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:

1. Escutcheons.

2. Floor plates.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Insulated Piping: One-piece, stamped-steel type.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
   d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   f. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

2. Escutcheons for Existing Piping:
   a. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
   b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
   c. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
   d. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
   e. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed hinge.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.

2. Existing Piping: Split-casting, floor-plate type.

3.3 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 23 05 18

SECTION 23 05 19 - METERS AND GAGES FOR HVAC 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:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.
6. Test-plug kits.
7. Sight flow indicators.
8. Venturi flowmeters.
9. Impeller-turbine, thermal-energy meters.

B. Related Sections:

1. Section 231123 "Facility Natural-Gas Piping" for gas meters.
2. Division 01 Section “Construction Waste Management”

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Trerice, H. O. Co.
   b. AMETEK
   c. Ashcroft
   d. Miljoca Corporation
   e. Taco
   f. Weiss Instruments
   g. Weksler

2. Standard: ASME B40.200.

3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.

4. Case Form: Adjustable angle unless otherwise indicated.

5. Tube: Glass with magnifying lens and blue organic liquid.

6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.

7. Window: Glass or plastic.

8. Stem: Aluminum and of length to suit installation.
   a. Design for Air-Duct Installation: With ventilated shroud.
   b. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.

10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.

2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.

3. Material for Use with Copper Tubing: CNR or CUNI.

4. Material for Use with Steel Piping: CRES.

5. Type: Stepped shank unless straight or tapered shank is indicated.

6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.

7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.

8. Bore: Diameter required to match thermometer bulb or stem.

9. Insertion Length: Length required to match thermometer bulb or stem.

10. Lagging Extension: Include on thermowells for insulated piping and tubing.

11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Trerice, H. O. Co.
   b. AMETEK
   c. Ashcroft
   d. Miljoca Corporation
   e. Taco
   f. Weiss Instruments
   g. Weksler

2. Standard: ASME B40.100.

3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 6-inch nominal diameter.

4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.

6. Movement: Mechanical, with link to pressure element and connection to pointer.

7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.

8. Pointer: Dark-colored metal.

9. Window: Glass or plastic.

10. Ring: Metal.

11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 or NPS 1/2 pipe threads.

C. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.6 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Trerice, H. O. Co.

2. AMETEK

3. Ashcroft

4. Miljoca Corporation

5. Taco

6. Weiss Instruments

7. Weksler

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: EPDM self-sealing rubber.

2.7 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Trerice, H. O. Co.
2. AMETEK
3. Ashcroft
4. Miljoca Corporation
5. Taco
6. Weiss Instruments
7. Weksler

B. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be at least 0 to 200 psig.

F. Carrying Case: Metal or plastic, with formed instrument padding.

2.8 SIGHT FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Archon Industries, Inc.
2. Dwyer Instruments, Inc.
3. Emerson Process Management; Brooks Instrument.
4. Ernst Co., John C., Inc.

5. Ernst Flow Industries.

6. KOBOLD Instruments, Inc. - USA; KOBOLD Messring GmbH.

7. OPW Engineered Systems; a Dover company.

8. Penberthy; A Brand of Tyco Valves & Controls - Prophetstown.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 150 psig.

E. Minimum Temperature Rating: 200 deg F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

2.9 FLOWMETERS

A. Venturi Flowmeters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ABB; Instrumentation and Analytical.
   b. Gerand Engineering Co.
   c. Hyspan Precision Products, Inc.
   d. Preso Meters; a division of Racine Federated Inc.
   e. S. A. Armstrong Limited; Armstrong Pumps Inc.
   f. Victaulic Company.

2. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.

3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

4. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.
   a. Design: Differential-pressure-type measurement for water.
   b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
   c. Minimum Pressure Rating: 250 psig.
   d. Minimum Temperature Rating: 250 deg F.
   e. End Connections for NPS 2 and Smaller: Threaded.
   f. End Connections for NPS 2-1/2 and Larger: Flanged or welded.
   g. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.

5. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch- diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
   a. Scale: Gallons per minute.
   b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.

6. Display: Shows rate of flow, with register to indicate total volume in gallons.

7. Conversion Chart: Flow rate data compatible with sensor.

8. Operating Instructions: Include complete instructions with each flowmeter.

2.10 THERMAL-ENERGY METERS

A. Impeller-Turbine, Thermal-Energy Meters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Data Industrial Corp.
   b. Hoffer Flow Controls, Inc.
   c. ISTEC Corporation.
   d. ONICON Incorporated.

2. Description: System with strainer, flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.

3. Flow Sensor: Impeller turbine with corrosion-resistant-metal body and transmitter; for installing in piping.
   a. Design: Total thermal-energy measurement.
   b. Minimum Pressure Rating: 150 psig.
   c. Minimum Temperature Range: 40 to 250 deg F.

4. Temperature Sensors: Insertion-type transducer.

5. Indicator: Solid-state, integrating-type meter with integral battery pack; for wall mounting.
   a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
   b. Battery Pack: Five-year lithium battery.

6. Accuracy: Plus or minus 1 percent.

7. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.

8. Strainer: Full size of main line piping.

9. Operating Instructions: Include complete instructions with each thermal-energy meter system.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Install thermowells at the supply and return for each boiler and chiller only.

E. Fill thermowells with heat-transfer medium.

F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

I. Install valve and snubber in piping for each pressure gage for fluids (except steam).

J. Install valve and syphon fitting in piping for each pressure gage for steam.

K. Install test plugs in piping tees.

L. Install flow indicators in piping systems in accessible positions for easy viewing.

M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

N. Install flowmeter elements in accessible positions in piping systems.

O. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

P. Install permanent indicators on walls or brackets in accessible and readable positions.

Q. Install connection fittings in accessible locations for attachment to portable indicators.

R. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

S. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.

2. Inlet and outlet of each geothermal circuit and main headers.

3. Inlet and outlet of each hydronic coil in air-handling units.

4. Two inlets and two outlets of each hydronic heat exchanger.

5. Inlet and outlet of each thermal-storage tank.

6. Outside-, return-, supply-, and mixed-air ducts.

T. Install pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.

2. Inlet and outlet of each condenser-water connection.

3. Suction and discharge of each pump.

3.3 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

3.4 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.5 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each hydronic zone shall be the following:

1. Industrial-style, liquid-in-glass type.

2. Test plug with EPDM self-sealing rubber inserts.

B. Thermometers at inlet and outlet of each geothermal circuit and main headers shall be the following:

1. Industrial-style, liquid-in-glass type.

2. Test plug with EPDM self-sealing rubber inserts.

C. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be the following:

1. Industrial-style, liquid-in-glass type.

2. Test plug with EPDM self-sealing rubber inserts.

D. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be the following:

1. Industrial-style, liquid-in-glass type.

E. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be the following:

1. Industrial-style, liquid-in-glass type.

F. Thermometer stems shall be of length to match thermowell insertion length.

3.6 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Ground Loop Heat Pump Piping: 0 to 150 deg F.

B. Scale Range for Air Ducts: 0 to 150 deg F.

3.7 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each pressure-reducing valve shall be the following:

1. Liquid-filled, direct-mounted, metal case.

2. Test plug with EPDM self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be the following:

1. Liquid-filled, direct-mounted, metal case.

2. Test plug with EPDM self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each pump shall be the following:

1. Liquid-filled, direct-mounted, metal case.

2. Test plug with EPDM self-sealing rubber inserts.

3.8 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Ground Loop Heat Pump Piping: 0 to 160 psi.

3.9 FLOWMETER SCHEDULE

A. Flowmeters for Ground Loop Heat Pump Piping: Venturi type.

3.10 THERMAL-ENERGY METER SCHEDULE

A. Thermal-Energy Meters for Ground Loop Heat Pump Piping: Impeller-turbine type.

END OF SECTION 23 05 19

SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC 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:

1. Brass ball valves.
2. Bronze ball valves.
3. High-performance butterfly valves.
4. Bronze swing check valves.
5. Iron, center-guided check valves.
6. Lubricated plug valves.
7. Chainwheels.

B. Related Sections:

1. Division 01 Section “Construction Waste Management”
2. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.1 for power piping valves.

3. ASME B31.9 for building services piping valves.

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 angle, gate, and globe valves closed to prevent rattling.

4. Set ball and plug 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 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.

2. Handwheel: For valves other than quarter-turn types.

3. Handlever: For quarter-turn valves NPS 6 and smaller.

4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every **10** plug valves, for each size square plug-valve head.

5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

2. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.

2. Grooved: With grooves according to AWWA C606.

3. Solder Joint: With sockets according to ASME B16.18.

4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American
   b. Apollo
   c. Milwaukee Valve
   d. Nibco
   e. Stockhom Valve and Fitting
   f. Walworth
   g. Watts

2. Description:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Forged brass.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American
   b. Apollo
   c. Milwaukee Valve
   d. Nibco
   e. Stockhom Valve and Fitting
   f. Walworth
   g. Watts

2. Description:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.

j. Port: Full.

2.4 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single-Flange, High-Performance Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Bray
   b. DeZurik
   c. Jamesbury
   d. Keystone
   e. Nibco

2. Description:
   a. Standard: MSS SP-68.
   b. CWP Rating: 285 psig at 100 deg F.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
   e. Seat: Reinforced PTFE or metal.
   f. Stem: Stainless steel; offset from seat plane.
   g. Disc: Stainless steel.
   h. Service: Bidirectional.

2.5 BRONZE LIFT CHECK VALVES

A. Class 125, Center Guided, Spring loaded,Lift Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Combination Pump and Valve
   b. Mueller Steam Specialty; a division of SPX Corporation.
   c. NIBCO INC.

2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig.
   c. Body Design: Vertical flow.
   d. Body Material: ASTM B 61 or ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: NBR, PTFE, or TFE.
   g. Stem and spring: Stainless Steel

2.6 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Combination Pump and Valve
   b. Mueller Steam Specialty; a division of SPX Corporation.
   c. NIBCO INC.

2. Description:
   a. Standard: MSS SP-80, Type 4.
   b. CWP Rating: 200 psig.
   c. Body Design: Horizontal flow.
   d. Body Material: ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: PTFE or TFE.
   g. Stem and spring: Stainless Steel

2.7 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Combination Pump and Valve
   b. Mueller Steam Specialty; a division of SPX Corporation.
   c. NIBCO INC.

2. Description:
   a. Standard: MSS SP-125.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   c. NPS 14 to NPS 24, CWP Rating: 150 psig.
   d. Body Material: ASTM A 126, gray iron.
   e. Style: Compact wafer.
   f. Seat: EPDM or NBR.

2.8 LUBRICATED PLUG VALVES

A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Nordstrom Valves, Inc.

2. Description:
   a. Standard: MSS SP-78, Type II.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.

c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
d. Pattern: Venturi.
e. Plug: Cast iron or bronze with sealant groove.

2.9 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Babbitt Steam Specialty Co.

2. Roto Hammer Industries.

3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.

2. Attachment: For connection to butterfly valve stems.

3. Sprocket Rim with Chain Guides: Bronze, of type and size required for valve. Include zinc coating.

4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.3 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.

3. Lift Check Valves: With stem upright and plumb.

3.4 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.5 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly valves.

2. Butterfly Valve Dead-End Service: Single-flange (lug) type.

3. Throttling Service except Steam: ball, or butterfly valves.

4. Pump-Discharge Check Valves:
   a. NPS 2 and Smaller: Bronze swing check valves with nonmetallic disc.
   b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, resilient-seat check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3. For Copper Tubing, NPS 5 and Larger: Flanged ends.

4. For Steel Piping, NPS 2 and Smaller: Threaded ends.

5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.6 GROUND LOOP HEAT PUMP VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.

2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.

3. Bronze Swing Check Valves: Class 125, nonmetallic disc.

B. Pipe NPS 2-1/2 and Larger:

1. High-Performance Butterfly Valves: Class 150, single flange.

2. Iron, Center-Guided Check Valves: Class 125, compact-wafer, resilient seat.

3. Lubricated Plug Valves: Class 125, threaded.

END OF SECTION 23 05 23

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC 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:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Sections:

1. Division 01 Section “Construction Waste Management”
2. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
3. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
4. Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
5. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.

2. Metal framing systems.

3. Pipe stands.

4. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.

2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.

3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

4. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.
   c. Flex-Strut Inc.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut Corporation; Tyco International, Ltd.
   g. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

3. Standard: MFMA-4.

4. Channels: Continuous slotted steel channel with inturned lips.

5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

6. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

7. Metallic Coating: Hot-dipped galvanized.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.

2. Clement Support Services.

3. ERICO International Corporation.

4. National Pipe Hanger Corporation.

5. PHS Industries, Inc.

6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.

7. Piping Technology & Products, Inc.

8. Rilco Manufacturing Co., Inc.

9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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 or shield for insulated piping.

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.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. 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.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

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 that 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 to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

5. Pipes NPS 8 and Larger: Include reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 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 bearing surface smooth.

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/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 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. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099600 "High Performance Coatings."

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

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

2. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

3. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

4. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

6. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

9. 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.

10. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

11. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

12. 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.

13. 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.

14. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-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. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

14. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC 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:

1. Isolation pads.
2. Isolation mounts.
3. Freestanding spring isolators.
4. Elastomeric hangers.
5. Spring hangers.
6. Pipe riser resilient supports.
7. Resilient pipe guides.
8. Restrained vibration isolation roof-curb rails.
9. Steel and inertia, vibration isolation equipment bases.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: 75 mph.

2. 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.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

B. Welding certificates.

C. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amber/Booth Company, Inc.

2. Kinetics Noise Control.

3. Mason Industries.

4. Vibration Eliminator Co., Inc.

5. Vibro-Acoustics.

6. Vibration Mountings & Controls, Inc.

B. 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.

C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or 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 rubber or 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.

D. 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.

E. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
2. Base: Factory drilled for bolting to structure.
3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

F. Elastomeric Hangers: Single or 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.

G. 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.

H. 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.

I. 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.

2.2 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amber/Booth Company, Inc.

2. Kinetics Noise Control.

3. Mason Industries.

4. Vibration Eliminator Co., Inc.

5. Vibro-Acoustics.

6. Vibration Mountings & Controls, Inc.

B. General Requirements for Restrained Vibration Isolation Roof-Curb Rails: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

C. Lower Support Assembly: Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

D. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch- thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or wind restraint.
   a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
   b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2. 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.
   a. Resilient Material: Oil- and water-resistant standard neoprene.

E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.3 VIBRATION ISOLATION EQUIPMENT BASES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Eliminator Co., Inc.
5. Vibro-Acoustics.
6. 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.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.

2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.

3. Baked enamel or powder coat for metal components on isolators for interior use.

4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- 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.

3.3 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by OSHPD.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.4 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

3. Install seismic-restraint devices using methods approved by OSHPD providing required submittals for component.

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.

2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.

3. Brace a change of direction longer than 12 feet.

D. Install cables so they do not bend across edges of adjacent equipment or building structure.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

H. 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.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.

3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.

4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.

5. Test to 90 percent of rated proof load of device.

6. Measure isolator restraint clearance.

7. Measure isolator deflection.

8. Verify snubber minimum clearances.

9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 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 air-spring leveling mechanism.

D. Adjust active height of spring isolators.

E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 05 48

SECTION 23 05 53 - IDENTIFICATION FOR HVAC 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:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Valve tags.
6. Warning tags.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 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 locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

2. Letter Color: White.

3. Background Color: Black.

4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Black.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches.

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.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Section 099123 "Interior Painting"

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

1. Ground Loop Heat Pump Piping:
   a. Background Color: Blue.
   b. Letter Color: White.

2. Refrigerant Piping:
   a. Background Color: Black.
   b. Letter Color: White.

3.5 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.

2. Yellow: For hot-air supply ducts.

3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels 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.

3.6 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and 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 subparagraphs:

1. Valve-Tag Size and Shape:
   a. Condenser Water: 1-1/2 inches, round.
   b. Refrigerant: 1-1/2 inches, round.
   c. Hot Water: 1-1/2 inches, round.
   d. Gas: 1-1/2 inches, round.

2. Valve-Tag Color:
   a. Condenser Water: Natural.
   b. Refrigerant: Green.
   c. Hot Water: Natural.
   d. Gas: Yellow.

3. Letter Color:
   a. Condenser Water: Black.
   b. Refrigerant: Black.
   c. Hot Water: Black.
   d. Gas: Black.

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 23 05 53

SECTION 23 05 93 - 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 the following:

1. Balancing Air Systems:
   a. Constant-volume air systems.
   b. Variable-air-volume systems.

2. Balancing Hydronic Piping Systems:
   a. Constant-flow hydronic systems.
   b. Variable-flow hydronic systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 ACTION SUBMITTALS

A. LEED Submittals:

1. Air-Balance Report for Prerequisite IEQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

2. TAB Report for Prerequisite EA 2: Documentation of work performed for ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:

1. Instrument type and make.

2. Serial number.

3. Application.

4. Dates of use.

5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by NEBB or TABB.

2. TAB Technician: Employee of the TAB contractor and who is certified by NEBB or TABB as a TAB technician.

B. TAB Conference: Meet with Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:
   a. The Contract Documents examination report.
   b. The TAB plan.
   c. Coordination and cooperation of trades and subcontractors.
   d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Owner.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 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.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

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 ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 233113 "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. 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.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. 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.

3.3 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare 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.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."

3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.5 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 outdoor-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. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.6 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 total airflow.
    a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:
    a. Measure outlet static pressure as far downstream from the fan as practical 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 the 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.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
   a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.

5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from Construction Manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. 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 mode 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 airflow of submain and branch ducts.
   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. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. 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 air 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 air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch 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.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance variable-air-volume systems the same as described for constant-volume air systems.

2. Set terminal units and supply fan at full-airflow condition.

3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

4. Readjust fan airflow for final maximum readings.

5. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.

6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.

7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
   a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
   a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

C. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.

3. Set terminal units at full-airflow condition.

4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

5. Adjust terminal units for minimum airflow.

6. Measure static pressure at the sensor.

7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.8 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 the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. 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 liquid level in expansion tank.

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.

3.9 PROCEDURES FOR CONSTANT-FLOW 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.
   a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Construction Manager and comply with requirements in Section 232123 "Hydronic Pumps."

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.
   a. Monitor motor performance during procedures and do not operate motors in overload conditions.

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 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. 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.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. 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.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.10 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.

3.11 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 settings and operation of safety and relief valves. Record settings.

3.12 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.

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 of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.13 PROCEDURES FOR GEOTHERMAL WELLS

A. Balance water flow through each well to within specified tolerances of indicated flow with all pumps operating. Measure and record the following data at design conditions:
   1. For condenser-water entering and leaving temperatures, pressure drop, and water flow.
   2. Capacity: Calculate in tons of cooling.

3.14 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.15 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water 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. Measure, adjust, and record the following data for each electric heating coil:

   1. Nameplate data.

   2. Airflow.

   3. Entering- and leaving-air temperature at full load.

   4. Voltage and amperage input of each phase at full load and at each incremental stage.

   5. Calculated kilowatt at full load.

   6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each refrigerant 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.

3.16 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 percent.

2. Air Outlets and Inlets: Plus or minus 5 percent.

3. Ground Loop Heat Pump Flow Rate: Plus or minus 5 percent.

3.17 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: Prepare biweekly progress 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.

3.18 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.

B. 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; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.

2. Name and address of the TAB contractor.

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 supervisor 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's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.

15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outdoor-, 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. Inlet vane settings for variable-air-volume systems.

g. Settings for supply-air, static-pressure controller.
h. Other system operating conditions that affect performance.

D. 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 outdoor, 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.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

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. Center-to-center dimensions of sheave, and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:
a. Motor 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. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
a. Total air flow 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. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.

F. 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. Air flow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches wg.
   d. Outdoor-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.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Fuel type in input data.
   g. Output capacity in Btu/h.
   h. Ignition type.
   i. Burner-control types.
   j. Motor horsepower and rpm.
   k. Motor volts, phase, and hertz.
   l. Motor full-load amperage and service factor.
   m. Sheave make, size in inches, and bore.

n. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):
   a. Total air flow rate in cfm.
   b. Entering-air temperature in deg F.
   c. Leaving-air temperature in deg F.
   d. Air temperature differential in deg F.
   e. Entering-air static pressure in inches wg.
   f. Leaving-air static pressure in inches wg.
   g. Air static-pressure differential in inches wg.
   h. Low-fire fuel input in Btu/h.
   i. High-fire fuel input in Btu/h.
   j. Manifold pressure in psig.
   k. High-temperature-limit setting in deg F.
   l. Operating set point in Btu/h.
   m. Motor voltage at each connection.
   n. Motor amperage for each phase.
   o. Heating value of fuel in Btu/h.

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:
   a. System identification.
   b. Location.
   c. Coil identification.
   d. Capacity in Btu/h.
   e. Number of stages.
   f. Connected volts, phase, and hertz.
   g. Rated amperage.
   h. Air flow rate in cfm.
   i. Face area in sq. ft..
   j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):
   a. Heat output in Btu/h.
   b. Air flow rate in cfm.
   c. Air velocity in fpm.
   d. Entering-air temperature in deg F.
   e. Leaving-air temperature in deg F.
   f. Voltage at each connection.
   g. Amperage for each phase.

I. 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. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:
a. Motor 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. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

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.

J. 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 air flow rate in cfm.
h. Indicated velocity in fpm.
i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm.

b. Air velocity in fpm.
c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

L. 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 number and serial number.
   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.

M. Instrument Calibration Reports:

1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

3.19 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. 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. Verify that balancing devices are marked with final balance position.
   e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation 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 Construction Manager.

2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Construction Manager.

3. Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. 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 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.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.20 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93

SECTION 23 07 13 - DUCT 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 insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, concealed oven and warewash exhaust.
7. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
8. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
9. Outdoor, exposed supply and return.

B. Related Sections:

1. Division 01 Section “Construction Waste Management”
2. Division 01 Section "LEED Requirements" for additional LEED requirements.
3. Section 230716 "HVAC Equipment Insulation."
4. Section 230719 "HVAC Piping Insulation."
5. Section 233113 "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit IEQ 4: For adhesives and 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."

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.

3. Detail application of field-applied jackets.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

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.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing 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.

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.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM 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. 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 II with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Certain-Teed Corporation
   b. Armacell LLC; AP Armaflex.
   c. Childers

d. Foster
e. Johns Manville
f. Knauf Fiber Glass
g. Owens-Corning

G. 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. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Certain-Teed Corporation
   b. Armacell LLC; AP Armaflex.
   c. Childers
   d. Foster
   e. Johns Manville
   f. Knauf Fiber Glass
   g. Owens-Corning

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a **2**-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Certain-Teed Corporation
   b. Armacell LLC; AP Armaflex.
   c. Childers
   d. Foster
   e. Johns Manville
   f. Knauf Fiber Glass
   g. Owens-Corning

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a **2**-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; FlameChek.
   b. Johns Manville; Firetemp Wrap.
   c. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
   d. Thermal Ceramics; FireMaster Duct Wrap.
   e. 3M; Fire Barrier Wrap Products.
   f. Unifrax Corporation; FyreWrap.

2.3 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. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.Eagle Bridges - Marathon Industries; 225.
   b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive 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."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
   b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
   b. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.

4. Service Temperature Range: 0 to plus 180 deg F.

5. Color: White.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.Eagle Bridges - Marathon Industries; 405.
   b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   c. Mon-Eco Industries, Inc.; 44-05.

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.

6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants 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."

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas No. 5.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Manufactured panel ductwork insulation system for outdoor ducts:

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. Techna-Duc

2.10 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

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. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 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.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

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. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   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.

2.11 SECUREMENTS

A. Bands:

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. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

2.12 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.4 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct 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. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal 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.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. 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, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.5 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 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.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: 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.

1. Comply with requirements in Section 078413 "Penetration Firestopping" and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: 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. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

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. 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 from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch 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 at 18-foot 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 two times the insulation thickness, but not less than 3 inches.

4. 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.

5. 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.

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.

B. 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 from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch 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 at 18-foot 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 two times the insulation thickness, but not less than 3 inches.

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.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. 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.

B. 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.

3.8 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 fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless-steel jackets.

3.10 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.

2. Indoor, exposed supply and outdoor air.

3. Indoor, concealed return located in unconditioned space.

4. Indoor, exposed return located in unconditioned space.

5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.

6. Indoor, concealed oven and warewash exhaust.

7. Indoor, concealed exhaust between isolation damper and penetration of building exterior.

8. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

9. Outdoor, concealed supply and return.

10. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.

2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.

3. Factory-insulated flexible ducts.

4. Factory-insulated plenums and casings.

5. Flexible connectors.

6. Vibration-control devices.

7. Factory-insulated access panels and doors.

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density for space between ceiling and roof.

B. Concealed, round and flat-oval, return-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density for space between ceiling and roof.

C. Concealed, round and flat-oval, outdoor-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density for space between ceiling and roof.

D. Concealed, round and flat-oval, exhaust-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

E. Concealed, rectangular, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density for space between ceiling and roof.

F. Concealed, rectangular, return-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density for space between ceiling and roof.

G. Concealed, rectangular, outdoor-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density for space between ceiling and roof.

H. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

I. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

J. Exposed, round and flat-oval, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density for space between ceiling and roof.

K. Exposed, round and flat-oval, return-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density for space between ceiling and roof.

L. Exposed, round and flat-oval, outdoor-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density for space between ceiling and roof.

M. Exposed, round and flat-oval, exhaust-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density for space between ceiling and roof.

N. Exposed, rectangular, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density for space between ceiling and roof.

O. Exposed, rectangular, return-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density for space between ceiling and roof.

P. Exposed, rectangular, outdoor-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density for space between ceiling and roof.

Q. Exposed, rectangular, exhaust-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density for space between ceiling and roof.

3.12 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Exposed, round and flat-oval, supply-air duct insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

C. Exposed, round and flat-oval, return-air duct insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

D. Exposed, rectangular, supply-air duct insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

E. Exposed, rectangular, return-air duct insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1. None.

D. Ducts and Plenums, Exposed:

1. Canvas jacketing within mechanical rooms and penthouse as well as exposed in storage rooms.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, Smooth: 0.032 inch thick.

D. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Aluminum, Smooth with 1-1/4-Inch- Deep Corrugations: 0.032 inch thick.

END OF SECTION 23 07 13

SECTION 23 07 16 - HVAC EQUIPMENT 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 insulating the following HVAC equipment that is not factory insulated:

1. Condenser-water pumps.

2. Expansion/compression tanks.

3. Air separators.

B. Related Sections:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

3. Section 230713 "Duct Insulation."

4. Section 230719 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit IEQ 4: For adhesives and 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."

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

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.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

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.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM 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. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Certain-Teed Corporation
   b. Armacell LLC; AP Armaflex.
   c. Childers
   d. Foster
   e. Johns Manville
   f. Knauf Fiber Glass
   g. Owens-Corning

2.2 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. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Certain-Teed Corporation
   b. Armacell LLC; AP Armaflex.
   c. Childers
   d. Foster
   e. Johns Manville
   f. Knauf Fiber Glass
   g. Owens-Corning

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive 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."

C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive 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."

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

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. Foster Brand, Specialty Construction Brands, Inc., a business of H .B. Fuller Company; 30-80/30-90.
   b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

5. Color: White.

2.4 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.

B. FSK and Metal Jacket Flashing Sealants:

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

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.

6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants 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."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 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.

6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants 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."

2.5 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. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Metal Jacket:

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   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. Finish and thickness are indicated in field-applied jacket schedules.
   c. Among the three moisture barriers in first subparagraph below, 1-mil (0.025-mm) barrier provides the least protection against galvanic corrosion, 3-mil (0.075-mm) barrier offers better protection, and polysurlyn barrier offers the best protection. For most indoor applications, 1-mil (0.025-mm) barrier is adequate. For outdoor applications, retain either 3-mil (0.075-mm) or polysurlyn barrier.
   d. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper
   e. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed two-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.

2.7 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

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. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 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.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

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. ABI, Ideal Tape Division; 370 White PVC tape.
   b. Compac Corporation; 130.
   c. 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.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

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. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   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.

2.8 SECUREMENTS

A. Bands:

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. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inchide with wing seal or closed seal.

2.9 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.4 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal 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 insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. 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, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.

2. Testing agency labels and stamps.

3. Nameplates and data plates.

4. Manholes.

5. Handholes.

6. Cleanouts.

3.5 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. 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.

B. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

2. Fabricate boxes from aluminum, 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.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. 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.

3.7 FINISHES

A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
   a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.8 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Ground loop heat pump-water pump insulation shall be the following:

1. Flexible Elastomeric: 1-1/2 inch thick.

D. Ground loop heat pump-water air-separator insulation shall be the following:

1. Flexible Elastomeric: 1-1/2 inch thick.

3.9 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. None.

C. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. None.

3.10 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, Smooth: 0.016 inch thick.

D. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Aluminum, Smooth with 1-1/4-Inch- Deep Corrugations: 0.032 inch thick.

END OF SECTION 23 07 16

SECTION 23 07 19 - HVAC PIPING 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 insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.

2. Condenser-water, indoors and outdoors.

3. Refrigerant suction and hot-gas piping, indoors and outdoors.

B. Related Sections:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

3. Section 230713 "Duct Insulation."

4. Section 230716 "HVAC Equipment Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit IEQ 4: For adhesives and 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."

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2. Detail attachment and covering of heat tracing inside insulation.

3. Detail insulation application at pipe expansion joints for each type of insulation.

4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

5. Detail removable insulation at piping specialties.

6. Detail application of field-applied jackets.

7. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

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.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping 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.

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.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM 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 "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Armacell
   b. Certain-Teed Corporation
   c. Childers

d. Foster
e. Johns Manville
f. Knauf Fiber Glass
g. Owens Corning
h. Vaporwick

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: Comply with ASTM C 552, Type II, Class 2.

7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:
a. Armacell
b. Certain-Teed Corporation
c. Childers
d. Foster
e. Johns Manville
f. Knauf Fiber Glass
g. Owens Corning
h. Vaporwick

2.2 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. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive 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."

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

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. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell LLC; Armaflex 520 Adhesive.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
   d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive 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."

E. PVC Jacket Adhesive: Compatible with PVC jacket.

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. Dow Corning Corporation; 739, Dow Silicone.
   b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
   c. P.I.C. Plastics, Inc.; Welding Adhesive.
   d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive 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."

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
   b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

5. Color: White.

2.4 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.

B. FSK and Metal Jacket Flashing Sealants:

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

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.

6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants 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."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 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.

6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants 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."

2.5 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. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Johns Manville; Zeston.
   b. P.I.C. Plastics, Inc.; FG Series.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.

3. Color: White.

4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.7 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

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. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 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.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

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. ABI, Ideal Tape Division; 370 White PVC tape.
   b. Compac Corporation; 130.
   c. 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.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

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. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   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.

2.8 SECUREMENTS

A. Bands:

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. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems 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.

3.3 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.

3.4 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of 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. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal 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.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. 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, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. 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.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.

2. Testing agency labels and stamps.

3. Nameplates and data plates.

4. Manholes.

5. Handholes.

6. Cleanouts.

3.5 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 Underground 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.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.6 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 and polyolefin, 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. 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. 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.

3.7 INSTALLATION OF CELLULAR-GLASS INSULATION

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. Instead, 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.

3.8 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

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.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. 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.

3.10 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
   a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.

2. Underground piping.

3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:
   a. Cellular Glass: 1-1/2 inches thick.

B. Ground Loop Heat Pump Supply and Return:

1. NPS 12 and Smaller: Insulation shall be the following:

   a. Cellular Glass: 1-1/2 inches thick.

C. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:
   a. Flexible Elastomeric: 1 inch thick.

D. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:
   a. Flexible Elastomeric: 1 inch thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Ground Loop Heat Pump Supply and Return:

1. All Pipe Sizes: Insulation shall be the following:

   a. Cellular Glass: 2 inches thick.

B. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:
   a. Flexible Elastomeric: 2 inches thick.

C. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:
   a. Flexible Elastomeric: 2 inches thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. PVC: 20 mils thick.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. PVC: 20 mils thick.

END OF SECTION 23 07 19

SECTION 23 09 00 - 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. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

3. Section 230519 "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

D. MS/TP: Master slave/token passing.

E. PC: Personal computer.

F. PID: Proportional plus integral plus derivative.

G. RTD: Resistance temperature detector.

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 Flow: Plus 5 percent of full scale.
   c. Water Pressure: Plus 2 percent of full scale.
   d. Space Temperature: Plus or minus 1 deg F.
   e. Ducted Air Temperature: Plus or minus 1 deg F.
   f. Outside Air Temperature: Plus or minus 2 deg F.
   g. Dew Point Temperature: Plus or minus 1 deg F.
   h. Temperature Differential: Plus or minus 0.25 deg F.
   i. Relative Humidity: Plus or minus 5 percent.
   j. Airflow (Measuring Stations): Plus 5 percent of full scale.
   k. Airflow (Terminal): Plus 10 percent of full scale.
   l. Air Pressure (Space): Plus or minus 0.01-inch wg.
   m. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
   n. Carbon Dioxide: Plus or minus 50 ppm.

1.5 ACTION SUBMITTALS

A. 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. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.

2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

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. Bill of materials of equipment indicating quantity, manufacturer, and model number.

2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.

3. Wiring Diagrams: Power, signal, and control wiring.

4. Details of control panel faces, including controls, instruments, and labeling.

5. Written description of sequence of operation.

6. Schedule of dampers including size, leakage, and flow characteristics.

7. Schedule of valves including flow characteristics.

8. DDC System Hardware:
   a. Wiring diagrams for control units with termination numbers.
   b. Schematic diagrams and floor plans for field sensors and control hardware.
   c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.

10. Controlled Systems:
    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.

b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
c. Written description of sequence of operation including schematic diagram.
d. Points list.

1.6 INFORMATIONAL SUBMITTALS

A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

B. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with LonWorks.

C. Qualification Data: For Installer and manufacturer.

D. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

E. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.

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.

B. 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.

1.8 MAINTENANCE MATERIAL SUBMITTALS

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. Replacement Materials: One replacement diaphragm or relay mechanism for each unique valve motor, controller, thermostat and positioning relay.

2. Maintenance Materials: One thermostat adjusting key(s).

B. The system shall be modular and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, building controllers, application specific controllers and operator devices. Provide a minimum of 25% spare capacity for all point types.

C. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

D. System shall include operating and software licenses for a minimum of 15 users.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components 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.

C. Comply with ASHRAE 135 for DDC system components.

1.10 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 equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.11 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Section 281000 "Access Control" to achieve compatibility with equipment that interfaces with that system.

C. Coordinate equipment with Section 27500 "Intercom and Clock" to achieve compatibility with equipment that interfaces with that system.

D. Coordinate equipment with Section 283100 "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.

E. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

F. Coordinate equipment with Section 262416 "Panelboards" to achieve compatibility with starter coils and annunciation devices.

G. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

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 CONTROL SYSTEM

A. Manufacturers:

1. Honeywell International Inc.; Home & Building Control.

2. Johnson Controls, Inc.; Controls Group.

3. Siemens Building Technologies, Inc.

4. Trane; Worldwide Applied Systems Group

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

C. Control system shall consist 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. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

D. Control system shall include the following:

1. Building clock control system specified in Section 275000 "Intercom and Clock"

2. Fire alarm system specified in Section 283100 "Fire Detection and Alarm."

2.3 DDC EQUIPMENT

A. Operator Workstation: One PC-based microcomputer(s) with minimum configuration as follows:

1. Motherboard: With 8 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.

2. Processor: Intel Pentium 4.

3. Random-Access Memory: 2 GB.

4. Graphics: Video adapter, minimum 1600 x 1200 pixels, 2-GB video memory, with TV out.

5. Monitor: 17 inches, LCD color.

6. Keyboard: QWERTY, 105 keys in ergonomic shape.

7. Floppy-Disk Drive: 1.44 MB.

8. Hard-Disk Drive: 80 GB.

9. CD-ROM Read/Write Drive: 48x24x48.

10. Mouse: Three button, optical.

11. Uninterruptible Power Supply: 2 kVa.

12. Operating System: Microsoft Windows with high-speed Internet access.
    a. ASHRAE 135 Compliance: Workstation shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
    b. Retain subparagraph below if compliance with LonWorks is required.
    c. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.

13. Printer: Color, ink-jet type as follows:

14. Application Software:
    a. I/O capability from operator station.
    b. System security for each operator via software password and access levels.
    c. Automatic system diagnostics; monitor system and report failures.
    d. Database creation and support.
    e. Automatic and manual database save and restore.

f. Dynamic color graphic displays with up to **10** screen displays at once.
g. Custom graphics generation and graphics library of HVAC equipment and symbols.
h. Alarm processing, messages, and reactions.
i. Trend logs retrievable in spreadsheets and database programs.
j. Alarm and event processing.
k. Object and property status and control.
l. Automatic restart of field equipment on restoration of power.
m. Data collection, reports, and logs. Include standard reports for the following:
   1) Current values of all objects.
   2) Current alarm summary.
   3) Disabled objects.
   4) Alarm lockout objects.
   5) Logs.
n. Custom report development.
o. Utility and weather reports.
p. Workstation application editors for controllers and schedules.
q. Maintenance management.

15. Custom Application Software:
    a. English language oriented.
    b. Full-screen character editor/programming environment.
    c. Allow development of independently executing program modules with debugging/simulation capability.
    d. Support conditional statements.
    e. Support floating-point arithmetic with mathematic functions.
    f. Contains predefined time variables.

B. Diagnostic Terminal Unit: Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with minimum configuration as follows:

1. System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.

2. Processor: Intel Pentium 4.

3. Random-Access Memory: 512 MB.

4. Graphics: Video adapter, minimum 1024 x 768 pixels, 512-MB video memory.

5. Monitor: 17 inches, LCD color.

6. Keyboard: QWERTY 105 keys in ergonomic shape.

7. Floppy-Disk Drive: 1.44 MB.

8. Hard-Disk Drive: 800 MB.

9. CD-ROM Read/Write Drive: 48x24x48.

10. Pointing Device: Touch pad or other internal device.

C. Building controllers: shall provide fully distributed building control independent of the operational status of the operator workstation and system server

1. All control logic shall be operator defined and fully adjustable and or programmable through operator interface.

2. Provide connection between all building controllers and the primary controlling LAN.

3. Each building controller shall permit mutli-user operation from multiple workstations and portable operator terminals connected either locally or over the primary controlling LAN

4. Provide a communication power for operator interface through a terminal at each building controller.

5. Owner shall be capable of uploading the most current versions of all energy management programs, DDC programs, database parameters, and all other data and programs in the memory of each building controller to the operator workstation through the LAN, Ethernet, or laptop PC.

6. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.

7. Stand-alone mode control functions operate regardless of network status. Functions include the following:
   a. Global communications.
   b. Discrete/digital, analog, and pulse I/O.
   c. Monitoring, controlling, or addressing data points.
   d. Software applications, scheduling, and alarm processing.
   e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

8. Standard Application Programs:
   a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
   b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
   c. Geothermal Control Programs: Control function of condenser-water reset and equipment sequencing.
   d. Dedicated Outdoor Air Unit Control programs.
   e. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
   f. Remote communications.
   g. Maintenance management.
   h. Units of Measure: Inch-pound and SI (metric).

9. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

10. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

D. On Site DDC Controller: Shall be minimum of 14" display with capability of showing full graphic with manual change over switch for winter / summer operations. Controller shall permit the following functions:

1. Configure system.

2. Monitor and supervise control all points

3. Modify control set points.

4. Override input and output values.

5. Enter time schedules.

6. View and acknowledge alarms and messages.

7. Receive, store and display trend logs and management reports.

8. Upload / download programs and database.

9. Report printability

10. Display full graphic of all equipment n school with plan operation.

E. Advanced application specific controller (AAC) and application specific controllers (ASC)

1. AAC and ASC shall provide intelligent, stand alone control of mechanical equipment

2. Provide all control capabilities and hardware system components below:
   a. Share information with other building controllers
   b. Provide self testing diagnostic capabilities, allowing each controller to alarm to the building controller, LAN interface device, or operator workstation
   c. Provide capability of modifying all point data, control algorithms, and software within the AAC/ASC from the workstation
   d. Provide sufficient memory to perform required control functions and communicate with other devices
   e. Provide any volative memory with a battery backup of fifty hours and battery life of five years.

F. Local supervisory LAN gateway/routers

1. Microprocessor based communication devices act as gateway between the supervisory LAN operator workstation and primary LAN

2. Supervisory gateway shall permit the following:

a. Centralized overall system supervision
b. Operator interface
c. Management report generation
d. Alarm annunciation
e. Access to trend data
f. Communication with control units
g. Configure systems
h. Monitor and supervise control of all points
i. Modify control setpoints
j. Override input and output values
k. Enter time schedules
l. View and acknowledge alarms and messages
m. Receive, store and display trend logs and management reports
n. Upload/download programs and databases

3. Provide a minimum one hundred hour self-charging battery backup for the supervisory gateway, programs, and associated data.

G. Graphical User Interface

1. Building picture with navigation

2. Floor plans

3. Thermographic indicators of space temperature

4. Navigation to equipment status, alarms, reports and dashboards

5. 3D equipment graphics

6. System graphics

7. System level dashboards

H. System Functionality and operational requirements

1. Time, Calendar, Holiday scheduling

2. Temporary Override schedule

3. Optimal start/stop based on space and outdoor air temperatures

4. Night setback, morning warm up

5. Economizer operation

6. Peak demand limiting/load shedding

7. Dead band control

8. Alarm management

9. Collection and analysis of data

10. Acquisition and storage of data

11. Time program commands

12. Standard reports and logs
    a. All points alarm, override
    b. Current value of all points
    c. Reports shall be exportable in CSV, HTML, XML or PDF format

I. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.

2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.

3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.

4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.

5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.

6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.

7. Universal I/Os: Provide software selectable binary or analog outputs.

J. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.

2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.

3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

K. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.

2. Maximum response time of 10 nanoseconds.

3. Minimum transverse-mode noise attenuation of 65 dB.

4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.13 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and **72**-hour battery backup.

2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.

3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.

4. LonWorks Compliance: Communicate using EIA/CEA 709.1 datalink/physical layer protocol using LonTalk protocol.

5. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

6. Enclosure: Waterproof rated for operation at 40 to 150 deg F.

2.14 ALARM PANELS

A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate 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.

B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.

1. Alarm Condition: Indicating light flashes and horn sounds.

2. Acknowledge Switch: Horn is silent and indicating light is steady.

3. Second Alarm: Horn sounds and indicating light is steady.

4. Alarm Condition Cleared: System is reset and indicating light is extinguished.

5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.15 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

D. 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.

E. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.

1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.

2. Proportional band shall extend from 2 to 20 percent for 5 psig.

3. Authority shall be 20 to 200 percent.

4. Air-supply pressure of 18 psig, input signal of 3 to 15 psig, and output signal of zero to supply pressure.

5. Gages: 3-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

2.16 TIME CLOCKS

A. Manufacturers:

1. ATC-Diversified Electronics.

2. Grasslin Controls Corporation.

3. Paragon Electric Co., Inc.

4. Precision Multiple Controls, Inc.

5. SSAC Inc.; ABB USA.

6. TCS/Basys Controls.

7. Theben AG - Lumilite Control Technology, Inc.

8. Time Mark Corporation.

B. Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.

C. Solid-state, programmable time control with four (4) separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

2.17 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Manufacturers:
   a. BEC Controls Corporation.
   b. Ebtron, Inc.
   c. Heat-Timer Corporation.
   d. I.T.M. Instruments Inc.
   e. MAMAC Systems, Inc.
   f. RDF Corporation.

2. Accuracy: Plus or minus 0.5 deg F at calibration point.

3. Wire: Twisted, shielded-pair cable.

4. 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.

5. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.

6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.

7. Room Sensor Cover Construction: Manufacturer's standard locking covers.

a. Set-Point Adjustment: Concealed.
b. Set-Point Indication: Concealed.
c. Thermometer: Concealed.
d. Orientation: Vertical.

8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. RTDs and Transmitters:

1. Manufacturers:
a. BEC Controls Corporation.
b. MAMAC Systems, Inc.
c. RDF Corporation.

2. Accuracy: Plus or minus 0.2 percent at calibration point.

3. Wire: Twisted, shielded-pair cable.

4. 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.

5. Averaging Elements in Ducts: 24 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.

6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.

7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
a. Set-Point Adjustment: Concealed.
b. Set-Point Indication: Concealed.
c. Thermometer: Concealed.
d. Orientation: Vertical.

8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

D. Humidity Sensors: Bulk polymer sensor element.

1. Manufacturers:
a. BEC Controls Corporation.
b. General Eastern Instruments.
c. MAMAC Systems, Inc.
d. ROTRONIC Instrument Corp.
e. TCS/Basys Controls.
f. Vaisala.

2. Accuracy: 2 percent full range with linear output.

3. Room Sensor Range: 10 to 90 percent relative humidity.

4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
   a. Set-Point Adjustment: Concealed.
   b. Set-Point Indication: Concealed.
   c. Thermometer: Concealed.
   d. Orientation: Vertical.

5. Duct Sensor: 10 to 90 percent relative humidity range with element guard and mounting plate.

6. Outside-Air Sensor: 10 to 90 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F.

7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Pressure Transmitters/Transducers:

1. Manufacturers:
   a. BEC Controls Corporation.
   b. General Eastern Instruments.
   c. MAMAC Systems, Inc.
   d. ROTRONIC Instrument Corp.
   e. TCS/Basys Controls.
   f. Vaisala.

2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
   a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
   b. Output: 4 to 20 mA.
   c. Building Static-Pressure Range: 0- to 0.25-inch wg.
   d. Duct Static-Pressure Range: 0- to 5-inch wg.

3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.

4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.

5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.

6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

F. Room Sensor Cover Construction: Manufacturer's standard locking covers.

1. Set-Point Adjustment: Concealed.

2. Set-Point Indication: Concealed.

3. Thermometer: Concealed.

4. Orientation: Vertical.

G. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.

2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.

3. Adjusting Key: As required for calibration and cover screws.

2.18 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

1. Manufacturers:
   a. BEC Controls Corporation.
   b. I.T.M. Instruments Inc.

2.19 GAS DETECTION EQUIPMENT

A. Manufacturers:

1. B. W. Technologies.
2. CEA Instruments, Inc.
3. Ebtron, Inc.
4. Gems Sensors Inc.
5. Greystone Energy Systems Inc.
6. Honeywell International Inc.; Home & Building Control.
7. INTEC Controls, Inc.
8. I.T.M. Instruments Inc.
9. MSA Canada Inc.
10. QEL/Quatrosense Environmental Limited.
11. Sauter Controls Corporation.
12. Sensidyne, Inc.
13. TSI Incorporated.
14. Vaisala.
15. Vulcain Inc.

B. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output;, for wall mounting.

1. Wall or duct insertion type, 0-2000 ppm range, typical accuracy of +/- 30 ppm or +/- 2% of reading between 60 and 90 degrees F.

C. 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.

2.20 FLOW MEASURING STATIONS

A. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.

1. Manufacturers:
   a. Air Monitor Corporation.

b. Wetmaster Co., Ltd.

2. Casing: Galvanized-steel frame.

3. Flow Straightener: Aluminum honeycomb, 3/4-inch parallel cell, 3 inches deep.

4. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

5. Total installed system accuracy: within 3 percent of actual flow.

6. Electronic flow transmitters: Industrial process control type, capable of receiving signals from the airflow measuring device and producing a 4-20 ma DC or 0-5 VDC output signal.

2.21 THERMOSTATS

A. Manufacturers:

1. Erie Controls.

2. Danfoss Inc.; Air-Conditioning and Refrigeration Div.

3. Heat-Timer Corporation.

4. Sauter Controls Corporation.

5. tekmar Control Systems, Inc.

6. Theben AG - Lumilite Control Technology, Inc.

B. Electric, solid-state, microcomputer-based room thermostat with remote sensor.

1. Automatic switching from heating to cooling.

2. Preferential rate control to minimize overshoot and deviation from set point.

3. Set up for four separate temperatures per day.

4. Thermostat to not allow override at the thermostat.

5. Short-cycle protection.

6. Programming based on every day of week.

7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.

8. Battery replacement without program loss.

9. Thermostat display features include the following:

a. Time of day.
b. Actual room temperature.
c. Day of week.
d. System mode indications include "heating," "off," "fan auto," and "fan on."

C. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.

2. Selector Switch: Integral, manual on-off-auto.

D. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet.

2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

E. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.

1. Bulb Length: Minimum 20 feet.

2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

2.22 HUMIDISTATS

A. Manufacturers:

1. MAMAC Systems, Inc.

2. ROTRONIC Instrument Corp.

B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.23 ENTHALPY SENSORS

A. Manufacturers:

1. MAMAC Systems, Inc.

2. ROTRONIC Instrument Corp.

B. Shall have a range of 16-40 BTU/lb. dry air.

C. Unit shall be suitable for duct mounting.

2.24 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.

5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers:
   a. Belimo Aircontrols (USA), Inc.

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.

3. Dampers: Size for running torque calculated as follows:
   a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
   b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
   c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
   d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
   e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
   f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

4. Coupling: V-bolt and V-shaped, toothed cradle.

5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.

6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.

7. Power Requirements (Two-Position Spring Return): 24-V ac.

8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.

9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.

10. Temperature Rating: Minus 22 to plus 122 deg F.

11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.

12. Run Time: 12 seconds open, 5 seconds closed.

2.25 CONTROL VALVES

A. Manufacturers:

1. Danfoss Inc.; Air Conditioning & Refrigeration Div.

2. Erie Controls.

3. Hayward Industrial Products, Inc.

4. Magnatrol Valve Corporation.

5. Neles-Jamesbury.

6. Parker Hannifin Corporation; Skinner Valve Division.

7. Pneuline Controls.

8. Sauter Controls Corporation.

B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.

2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

4. Sizing: 3-psig maximum pressure drop at design flow rate or the following:
   a. Two Position: Line size.
   b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
   c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

1. Body Style: Wafer.

2. Disc Type: Aluminum bronze.

3. Sizing: 1-psig maximum pressure drop at design flow rate.

E. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.

2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.

3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

F. Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.

2. Thermostatic Operator: integral sensor with integral adjustable dial.

2.26 DAMPERS

A. Manufacturers:

1. Air Balance Inc.

2. Don Park Inc.; Autodamp Div.

3. TAMCO (T. A. Morrison & Co. Inc.).

4. United Enertech Corp.

5. Vent Products Company, Inc.

B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

2. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.

3. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Conditioned power is not available on most projects; confirm its availability.

B. Verify that power supply is available to control units and operator workstation.

C. Verify that pneumatic piping and duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

3.3 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Mount compressor and tank unit on elastomeric mounts. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment." Isolate air supply with wire-braid-reinforced rubber hose. Secure and anchor according to manufacturer's written instructions and seismic-control requirements.

1. Pipe manual and automatic drains to nearest floor drain.

2. Supply instrument air from compressor units through filter, pressure-reducing valve, and pressure relief valve, with pressure gages and shutoff and bypass valves.

D. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

E. Install guards on thermostats in the following locations:

1. Entrances.

2. Public areas.

3. Where indicated.

F. Install automatic dampers according to Section 233300 "Air Duct Accessories."

G. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

H. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."

I. Install hydronic instrument wells, valves, and other accessories according to Section 232113 "Hydronic Piping."

J. Install refrigerant instrument wells, valves, and other accessories according to Section 232300 "Refrigerant Piping."

K. Install duct volume-control dampers according to Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts."

3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Section 260533 "Conduits."

B. Install building wire and cable according to Section 260519 "Building Wire and Cable."

C. Install signal and communication cable according to Section 270500 "Telecommunications Pathway."

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.

2. Install exposed cable in raceway.

3. Install concealed cable in raceway.

4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.

5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

B. 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 unit operation. Remove and replace malfunctioning units and retest.

2. Test and adjust controls and safeties.

3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

4. Test each point through its full operating range to verify that safety and operating control set points are as required.

5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.

6. Test each system for compliance with sequence of operation.

7. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.

2. Check instruments for proper location and accessibility.

3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

4. Check instrument tubing for proper fittings, slope, material, and support.

5. Check installation of air supply for each instrument.

6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.

7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.

8. Check temperature instruments and material and length of sensing elements.

9. Check control valves. Verify that they are in correct direction.

10. Check DDC system as follows:
    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.

2. Make three-point calibration test for both linearity and accuracy for each analog instrument.

3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

4. Control System Inputs and Outputs:
   a. Check analog inputs at 0, 50, and 100 percent of span.
   b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
   c. Check digital inputs using jumper wire.
   d. Check digital outputs using ohmmeter to test for contact making or breaking.
   e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:
   a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
   b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:
   a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
   b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:
   a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
   b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.

10. Provide diagnostic and test instruments for calibration and adjustment of system.

11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. 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 three visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 09 00

SECTION 23 11 23 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Service meters.
7. Concrete bases.

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 and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: 2 psig or less.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. Corrugated, stainless-steel tubing with associated components.
3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Dielectric fittings.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

B. Welding certificates.

C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For motorized gas valves, pressure regulators to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.9 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 and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.10 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

1.11 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.
    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

6. Mechanical Couplings:

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Dresser Piping Specialties; Division of Dresser, Inc.
        2) Smith-Blair, Inc.

    b. Steel flanges and tube with epoxy finish.
    c. Buna-nitrile seals.
    d. Stainless-steel bolts, washers, and nuts.
    e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. OmegaFlex, Inc.
    b. Parker Hannifin Corporation; Parflex Division.
    c. Titeflex.
    d. Tru-Flex Metal Hose Corp.

2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
3. Coating: PE with flame retardant.

    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) Flame-Spread Index: 25 or less.
        2) Smoke-Developed Index: 50 or less.

4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
5. Striker Plates: Steel, designed to protect tubing from penetrations.
6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
7. Operating-Pressure Rating: 5 psig.

C. Drawn-Temper Copper Tube: Comply with ASTM B 88, Type L.

1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.

2. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.

    a. Gasket Material: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    b. Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.

D. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type L.

1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
2. Flare Fittings: Comply with ASME B16.26 and SAE J513.

    a. Copper fittings with long nuts.
    b. Metal-to-metal compression seal without gasket.
    c. Dryseal threads complying with ASME B1.20.3.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Corrugated stainless-steel tubing with polymer coating.
4. Operating-Pressure Rating: 0.5 psig.
5. End Fittings: Zinc-coated steel.
6. Threaded Ends: Comply with ASME B1.20.1.
7. Maximum Length: 72 inches.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Article.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Article.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following

a. BrassCraft Manufacturing Company; a Masco company.
b. Conbraco Industries, Inc.; Apollo Div.
c. Lyall, R. W. & Company, Inc.
d. McDonald, A. Y. Mfg. Co.
e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.

7. Ends: Threaded, flared, or socket as indicated in “Aboveground Manual Gas Shutoff Valve Schedule" Article.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Lee Brass Company.
    b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in “Aboveground Manual Gas Shutoff Valve Schedule" Article.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. McDonald, A. Y. Mfg. Co.
    b. Mueller Co.; Gas Products Div.
    c. Xomox Corporation; a Crane company.

2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Article.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Flowserve.
   b. Homestead Valve; a division of Olson Technologies, Inc.
   c. McDonald, A. Y. Mfg. Co.
   d. Milliken Valve Company.
   e. Mueller Co.; Gas Products Div.
   f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.

2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in “"Aboveground Manual Gas Shutoff Valve Schedule" Article.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 MOTORIZED GAS VALVES

A. Automatic Gas Valves: Comply with ANSI Z21.21.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ASCO Power Technologies, LP; Division of Emerson.
   b. Dungs, Karl, Inc.
   c. Eaton Corporation; Controls Div.
   d. Eclipse Combustion, Inc.
   e. Honeywell International Inc.
   f. Johnson Controls.

2. Body: Brass or aluminum.
3. Seats and Disc: Nitrile rubber.
4. Springs and Valve Trim: Stainless steel.
5. Normally closed.
6. Visual position indicator.
7. Electrical operator for actuation by appliance automatic shutoff device.

B. Electrically Operated Valves: Comply with UL 429.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ASCO Power Technologies, LP; Division of Emerson.
   b. Dungs, Karl, Inc.
   c. Eclipse Combustion, Inc.
   d. Goyen Valve Corp.; Tyco Environmental Systems.
   e. Magnatrol Valve Corporation.
   f. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
   g. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

2. Pilot operated.
3. Body: Brass or aluminum.
4. Seats and Disc: Nitrile rubber.
5. Springs and Valve Trim: Stainless steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.
8. Normally closed.
9. Visual position indicator.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Actaris.
   b. American Meter Company.
   c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
   d. Invensys.
   e. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.

7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

C. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Actaris.
    b. American Meter Company.
    c. Eclipse Combustion, Inc.
    d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
    e. Invensys.
    f. Maxitrol Company.
    g. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 2 psig.

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Canadian Meter Company Inc.
    b. Eaton Corporation; Controls Div.
    c. Harper Wyman Co.
    d. Maxitrol Company.
    e. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.

3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 1 psig.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Capitol Manufacturing Company.
    b. Central Plastics Company.
    c. Hart Industries International, Inc.
    d. Jomar International Ltd.
    e. Matco-Norca, Inc.
    f. McDonald, A. Y. Mfg. Co.
    g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    h. Wilkins; a Zurn company.

2. Description:

    a. Standard: ASSE 1079.
    b. Pressure Rating: 125 psig minimum at 180 deg F.
    c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Capitol Manufacturing Company.
    b. Central Plastics Company.
    c. Matco-Norca, Inc.
    d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    e. Wilkins; a Zurn company.

2. Description:

    a. Standard: ASSE 1079.
    b. Factory-fabricated, bolted, companion-flange assembly.
    c. Pressure Rating: 125 psig minimum at 180 deg F.

d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

2.8 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

D. Install fittings for changes in direction and branch connections.

E. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."

3.4 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and Utility Company requirements for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

    a. Exception: Tubing passing through partitions or walls does not require striker barriers.

4. Prohibited Locations:

    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

1. Sleeves are not required for core drilled holes.

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

1. Sleeves are not required for core drilled holes.

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

Z. (A) Inject Mercaptan, in addition to that inherently in the natural gas, into the gas piping to system to counter act the absorption of the odor into the newly installed piping system.

3.5 SERVICE-METER ASSEMBLY INSTALLATION

A. Coordinate with the gas utility company to install service-meter assemblies aboveground, on concrete bases. Provide concrete pads and supports as required by the utility company to support the meter assembly.

B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

C. Install strainer on inlet of service-pressure regulator and meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.

F. Install service meters downstream from pressure regulators.

G. Install metal bollards to protect meter assemblies. Comply with requirements in Section 055000 "Metal Fabrications" for pipe bollards.

3.6 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.7 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

3.8 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

C. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2 and NPS 5/8: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and NPS 7/8: Maximum span, 84 inches; minimum rod size, 3/8 inch.
4. NPS 1: Maximum span, 96 inches; minimum rod size, 3/8 inch.

D. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.9 CONNECTIONS

A. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

B. Install piping adjacent to appliances to allow service and maintenance of appliances.

C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

A. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 PAINTING

A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (semigloss).
d. Color: Gray.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (semigloss).
d. Color: Yellow.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.13 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.14 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground natural-gas piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:

1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
2. Annealed-temper, copper tube with wrought-copper fittings and brazed or flared joints.
3. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.
3. Drawn-temper copper tube with wrought-copper fittings and brazed joints.

3.16 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:

1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
2. Annealed-temper, copper tube with wrought-copper fittings and brazed joints.
3. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with steel welding fittings and welded joints.
3. Drawn-temper copper tube with wrought-copper fittings and brazed joints.

3.17 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.

2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2and larger at service meter shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, lubricated plug valve.

E. Valves in branch piping for single appliance shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

END OF SECTION 23 11 23

SECTION 23 2113.34 - THERMAL-ENHANCED BENTONITE GROUT

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 SECTION INCLUDES

A. Requirements for furnishing, mixing, and placing thermally-enhanced bentonite grout to seal and backfill each vertical u-bend well bore of the closed-loop ground heat exchangers to insure proper thermal contact with the earth and to ensure the environmental integrity of each vertical bore column. No other backfill material shall be accepted.

1.3 REFERENCES

A. National Ground Water Association - geothermal heat pump manual-Guidelines for the

B. Construction of Vertical Boreholes for Closed Loop Heat Pump Systems

C. Local codes

1.4 SUBMITTALS

A. Manufacturer’s published data sheets including thermal conductivity, permeability, percent solids, grout weight, linear shrinkage potential, maximum particle size and unit yield along with verification of the required listing.

1.5 QUALITY ASSURANCE

A. Grouting compound shall be certified and listed by National Sanitation Foundation International to ANSI/NSF Standard 60, “Drinking Water Treatment Chemicals - Health Effects”.

PART 2 - PRODUCTS

2.1 MANUFACTURER/PRODUCT

A. Grout Products:

1. Aquagard
2. Aquagrout

3. Black Hills Grout
4. Enviroplug
5. Groutwell
6. Puregold
7. Quick Grout
8. Volclay Grout

B. Grouting: Materials to be utilized by the Contractor shall be a minimum of 20% high sodium solids bentonite grout. The bentonite will be a slurry that will be tremie grouted from the bottom of the boring to the surface in accordance with the IGSHPA installation manual. The mechanical contractor will work quickly to assure that there are no air voids forming as a result of the bentonite placing.

C. Grouting material shall be Black Hills Bentonite's Thermal Grout Select as supplied by GeoPro, Inc. or equivalent which is pre-approved by the Owner or Owner's representative.

2.2 THERMAL CONDUCTIVITY

A. The thermal conductivity of the grouting compound must be 1.5 Btu/hr-ft-F or greater.

2.3 PERMEABILITY

A. The grout mixture shall also have a maximum permeability rate of less than 6.9 x 10 -8 cm/s as determined by using the "Falling-Head Method" (defined in the United States Army Corps of Engineers' Civil Engineering Manual No. EM 1110-2-1906, "Laboratory Soils Testing" as recommended by the U.S. Environmental Protection Agency to insure proper sealing. Permeability shall be verified by an independent testing laboratory with a copy of the report being supplied upon request from the Owner or Owner's representative.

2.4 TOTAL SOLIDS AND ENHANCEMENT COMPOUND PERCENTAGE

A. The thermally-enhanced bentonite grout used shall have a minimum manufacturer's recommended mixture of 63.5% solids. The thermal enhancement compound (high-grade silica compound) shall constitute a minimum of 50% by weight of the aqueous slurry.

2.5 PACKAGING

A. Grouting materials shall be pre-manufactured and packaged prior to delivery to the job site.

PART 3 - EXECUTION

3.1 MIXING

A. Thermally-enhanced bentonite grouting material shall be mixed according to manufacturers' written instructions.

B. Mechanical Contractor shall monitor the grouting operation to ensure grout is properly mixed and the viscosity is adequately maintained for pumping.

C. Grout shall be mixed by a paddle type mixing device or by manufactured portable grouting unit specifically designed for the vertical ground heat exchanger industry. Jet mixing and recirculation are not allowed for grout.

3.2 INSTALLATION

A. Grout material shall be pressure pumped through a 1", 1-1/4" or 1-1/2" innside diameter tremie pipe and placed in the bore column from the bottom to the top. Grouting process shall conform to the manufacturer's instructions. Completed grouted surface shall be placed at ground level to ensure complete fill of the bore column.

B. Mechanical Contractor shall maintain a ready supply of spare grout pipes, hoses and fittings on the site.

C. A positive displacement pump shall be used for placing the grout in the borehole. Minimum pump suction and discharge lines shall be 3" and 1-1/2" respectively.

D. Drilling fluids shall be confined to the site and disposed of in accordance with prevailing local environmental regulations.

3.3 INSPECTION

A. Since some settling may occur after initial placement of the grout material, the Mechanical Contractor shall monitor each borehole and continue adding grout as required for a period of no less than 30 minutes and no longer than 2 hours.

B. Grouting manufacturer shall provide testing of site mixed grouting material to verify thermal conductivity. Manufacturer shall provide a minimum of 3 sample analyses for each project.

C. At a minimum, sampling shall be taken at the beginning of the project, at approximately one-third completion, and at approximately two-thirds completion. In the event that the analysis indicates a thermal conductivity value below the minimum specified value, corrective action shall be taken to increase thermal conductivity value back.

END OF SECTION 232113.34

SECTION 23 21 13 - 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 pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   1. Condenser-water piping.
   2. Makeup-water piping.
   3. Condensate-drain piping.
   4. Air-vent piping.
   5. Safety-valve-inlet and -outlet piping.

B. Related Sections include the following:
   1. Division 01 Section “Construction Waste Management”
   2. Division 01 Section "LEED Requirements" for additional LEED requirements.
   3. Section 232123 "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.3 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

B. RTRF: Reinforced thermosetting resin (fiberglass) fittings.

C. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.4 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
   1. Condenser-Water Piping: 150 psig at 80 deg F.

2. Makeup-Water Piping: 80 psig at 150 deg F.

3. Condensate-Drain Piping: 150 deg F.

4. Air-Vent Piping: 200 deg F.

5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Plastic pipe and fittings with solvent cement.

2. RTRP and RTRF with adhesive.

3. Pressure-seal fittings.

4. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

5. Air control devices.

6. Chemical treatment.

7. Hydronic specialties.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, 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."

C. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Welding certificates.

C. Field quality-control test reports.

D. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.9 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

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. 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 ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. 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.

H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 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 maximum thickness unless thickness or specific material is 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.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. 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.

E. 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.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. 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. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. Jomar International Ltd.
   e. Matco-Norca, Inc.
   f. McDonald, A. Y. Mfg. Co.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   h. Wilkins; a Zurn company.

2. Description:
   a. Standard: ASSE 1079.
   b. Revise pressure rating and temperature in first subparagraph below to suit Project, or insert other options for specific applications.
   c. Pressure Rating: 125 psig minimum at 180 deg F.
   d. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Matco-Norca, Inc.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   e. Wilkins; a Zurn company.

2. Description:
   a. Standard: ASSE 1079.
   b. Factory-fabricated, bolted, companion-flange assembly.
   c. Revise pressure rating in first subparagraph below to suit Project, or insert other options for specific applications.
   d. Pressure Rating: 125 psig minimum at 180 deg F.

e. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Description:
   a. Nonconducting materials for field assembly of companion flanges.
   b. Revise pressure rating in first subparagraph below to suit Project, or insert other options for specific applications.
   c. Pressure Rating: 150 psig.
   d. Gasket: Neoprene or phenolic.
   e. Bolt Sleeves: Phenolic or polyethylene.
   f. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

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. Elster Perfection.
   b. Grinnell Mechanical Products.
   c. Matco-Norca, Inc.
   d. Precision Plumbing Products, Inc.
   e. Victaulic Company.

2. Description:
   a. Standard: IAPMO PS 66
   b. Electroplated steel nipple. complying with ASTM F 1545.
   c. Revise pressure rating and temperature in first subparagraph below to suit Project, or insert other options for specific applications.
   d. Pressure Rating: 300 psig at 225 deg F
   e. End Connections: Male threaded or grooved.
   f. Lining: Inert and noncorrosive, propylene.

2.5 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523 "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230900 "Instrumentation and Control for HVAC."

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. American
   b. Apollo
   c. Milwaukee Valve
   d. Nibco
   e. Stockham Valve and Fitting
   f. Walworth
   g. Watts

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.

3. Ball: Brass or stainless steel.

4. Plug: Resin.

5. Seat: PTFE.

6. End Connections: Threaded or socket.

7. Pressure Gage Connections: Integral seals for portable differential pressure meter.

8. Handle Style: Lever, with memory stop to retain set position.

9. CWP Rating: Minimum 125 psig.

10. Maximum Operating Temperature: 250 deg F.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. American
   b. Apollo
   c. Milwaukee Valve
   d. Nibco
   e. Stockham Valve and Fitting
   f. Walworth
   g. Watts

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.

3. Ball: Brass or stainless steel.

4. Stem Seals: EPDM O-rings.

5. Disc: Glass and carbon-filled PTFE.

6. Seat: PTFE.

7. End Connections: Flanged or grooved.

8. Pressure Gage Connections: Integral seals for portable differential pressure meter.

9. Handle Style: Lever, with memory stop to retain set position.

10. CWP Rating: Minimum 125 psig.

11. Maximum Operating Temperature: 250 deg F.

E. Diaphragm-Operated, Pressure-Reducing Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. American
   b. Apollo
   c. Milwaukee Valve
   d. Nibco
   e. Stockham Valve and Fitting
   f. Walworth
   g. Watts

2. Body: Bronze or brass.

3. Disc: Glass and carbon-filled PTFE.

4. Seat: Brass.

5. Stem Seals: EPDM O-rings.

6. Diaphragm: EPT.

7. Low inlet-pressure check valve.

8. Valve Seat and Stem: Noncorrosive.

9. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. American
   b. Apollo

c. Milwaukee Valve
d. Nibco
e. Stockham Valve and Fitting
f. Walworth
g. Watts

2. Body: Bronze or brass.

3. Disc: Glass and carbon-filled PTFE.

4. Seat: Brass.

5. Stem Seals: EPDM O-rings.

6. Diaphragm: EPT.

7. Wetted, Internal Work Parts: Brass and rubber.

8. Valve Seat and Stem: Noncorrosive.

9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

G. Automatic Flow-Control Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. American
b. Apollo
c. Milwaukee Valve
d. Nibco
e. Stockham Valve and Fitting
f. Walworth
g. Watts

2. Body: Brass or ferrous metal.

3. Piston and Spring Assembly: Corrosion resistant, tamper proof, self cleaning, and removable.

4. Combination Assemblies: Include bonze or brass-alloy ball valve.

5. Identification Tag: Marked with zone identification, valve number, and flow rate.

6. Size: Same as pipe in which installed.

7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.

8. Minimum CWP Rating: 175 psig.

9. Maximum Operating Temperature: 200 deg F.

2.6 AIR CONTROL DEVICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amtrol, Inc.

2. Hoffman

3. ITT Bell and Gossett

4. Spirax Sarco

5. Spirotherm

6. Taco

B. Manual Air Vents:

1. Body: Bronze.

2. Internal Parts: Nonferrous.

3. Operator: Screwdriver or thumbscrew.

4. Inlet Connection: NPS 1/2.

5. Discharge Connection: NPS 1/8.

6. CWP Rating: 150 psig.

7. Maximum Operating Temperature: 225 deg F.

C. Bladder-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.

3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

D. In-Line Air Separators:

1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.

2. Maximum Working Pressure: Up to 175 psig.

3. Maximum Operating Temperature: Up to 300 deg F.

2.7 CHEMICAL TREATMENT

A. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

2.8 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 125 psig.

B. 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.

C. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.

2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.

3. Performance: Capable of misalignment.

4. CWP Rating: 150 psig.

5. Maximum Operating Temperature: 250 deg F.

D. Expansion fittings are specified in Section 230516 "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 PIPING APPLICATIONS

A. Condenser-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be the following:

1. Type L (B), drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

B. Condenser-water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be the following:
1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Condenser-water piping installed belowground and within slabs shall be the following:

1. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and brazed joints. Use the fewest possible joints.

D. Makeup-water piping installed aboveground shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

E. Makeup-Water Piping Installed Belowground and within Slabs: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

F. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

G. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

H. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

3.3 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.4 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. 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.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using [mechanically formed] tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Section 230516 "Expansion Fittings and Loops for HVAC Piping."

U. Identify piping as specified in Section 230553 "Identification for HVAC Piping and Equipment."

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. 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. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

D. 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.

10. NPS 10: Maximum span, 20 feet; minimum rod size, 3/4 inch.

11. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.

E. 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.

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.6 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. 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.

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.

3.7 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 at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

E. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

F. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.

2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

G. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.8 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Section 230519 "Meters and Gages for HVAC Piping."

3.9 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling.

B. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

C. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

3.10 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination 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 hydronic piping systems with clean water; then remove and clean or replace strainer screens.

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.

B. 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 is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working 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 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.

2. Inspect pumps for proper rotation.

3. Set makeup pressure-reducing valves for required system pressure.

4. Inspect 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. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.

7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13

SECTION 23 21 14 - GROUND-LOOP HEAT-PUMP 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 for vertical, direct-buried, ground-loop, heat-pump systems that operate between 23 and 104 deg F.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1. Ground-Loop, Heat-Pump Piping: 160 psig.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Pipe and fittings.
2. Joining method and equipment.
3. Propylene glycol solution.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.6 QUALITY CONTROL

A. Geothermal Piping Installer Qualifications: The persons performing geothermal work shall be personally certified in polyethylene pipe fusion techniques by IGSHPA or piping manufacturer, personally experienced in doing work of this nature, and shall have been regularly employed by a company performing geothermal work for a minimum of five (5) years. Contractor shall be able to furnish proof of certification for field personnel installing the piping, which shall be submitted with materials submittals.

B. Geothermal Piping Supervisor’s Qualifications: The supervisor overseeing the geothermal piping work shall be personally certified in polyethylene pipe fusion techniques by IGSHPA or

piping manufacturer, personally experienced in geothermal piping work of this nature, and shall have been regularly employed by a company performing work of this nature for a minimum of ten (10) years. Contractor shall be able to furnish proof of certification, which shall be submitted with materials submittals.

C. Factory Testing: Perform routine factory testing of factory fabricated equipment and materials in accordance with the agencies having jurisdiction.

D. Field Testing: Perform field testing of piping systems in accordance with the local authorities having jurisdiction.

1.7 WARRANTY

A. The piping manufacturer shall warrant against defects of material and workmanship for a period of fifty (50) years after the date of final acceptance by the owner for all direct-buried HDPE piping installed under the project scope.

1. Minimum fifty (50) year warranty of all piping, joints, and fittings. Warranty shall include all material and labor to replace defective portions of the system.
2. Manufacturer shall replace, at no cost to the owner, and defective piping or fitting materials, including all labor to install, within the specified warranty period.

PART 2 - PRODUCTS

2.1 PIPING

A. Ground loop heat exchange pipe shall be high-density crosslinked polyethylene manufactured using the high-pressure peroxide method of crosslinking (PEXa). Pipe shall conform to (a) ASTM F876 and (b) CSA B137.5 and (c) CSA C448 or (d) ISO 15875-1:2003, 15875-2:2003 or (e) DIN 16892 and 16893.

B. Pipe shall be rated for continuous operation of 100 psi gauge pressure at 180°F temperature, and 160 psi gauge pressure at 73.4°F temperature.

C. Horizontal Heat Exchanger:

1. The minimum bend radius for cold bending of the pipe shall be no less than five (5) times the outside diameter. Bends tighter than this minimum shall require the use of a bending template, as supplied by the pipe manufacturer, and hot air.

D. Vertical Borehole Heat Exchanger:

1. The vertical borehole heat exchanger tip shall be manufactured of one continuous pipe, with no joints in the borehole or shall be manufactured from coated stainless steel components manufactured to the ASTM F2080 standard.
2. The vertical borehole heat exchanger shall be a double U-bend system, consisting of 2 single U-bend pipes attached together.

3. The vertical borehole heat exchanger tip shall be covered in a GRP resin or a rubber coating.

2.2 FITTINGS

A. All buried fitting shall be of permanent design.

B. Cold-expansion compression-sleeve fittings shall conform and be third-party certified to ASTM F2080, and CSA B137.5.

C. Cold-expansion compression-sleeve fittings shall be manufactured of brass or stainless steel and shall be supplied by the piping manufacturer as part of a proven cataloged system.

D. All electrofusion fittings intended for ground loop heat exchange applications shall conform to ASTM F1055 or EN 1555-3.

2.3 MANIFOLDS

A. Material: Distribution manifolds shall be manufactured of brass or polypropylene and be supplied by the piping manufacturer as a part of a proven cataloged system.

B. Brass manifolds shall be produced from extruded brass round pipe with tapped holes for connections, and be pre-assembled by the manufacturer. 100% of manifolds used shall have been air tested by the manufacturer with no indication of leaks.

C. Polypropylene manifolds shall be produced from extruded polypropylene SDR 11 pipe containing a fiber layer to restrict thermal expansion. Holes shall be tapped for connections. Outlet ports shall be fusion welded onto the body of the manifold, with integrated fittings for connection to the borehole field. Fusion welding shall be done in a factory setting to ensure quality of the manifold. Manifold shall be supplied by the manufacturer with all components pressure tested and with no indication of leaks.

D. Balancing Manifolds:

1. Where required by design, manifolds shall be equipped with supply and return manifold isolation valves, integral thermometer and manometer housings, and air vent/fill ports.
2. Where required by design, each circuit shall be supplied with circuit isolation valves, integral visual flow gauges and brass cold expansion compression-sleeve fittings to connect to IGSHPA-approved PEXa pipe.

2.4 BOREHOLE BACKFILL

A. Surface Seal: Bentonite with thermal conductivity greater than 1.2 Btu/h x sq. ft. x deg F.

B. Backfill below Surface Seal: Natural or manufactured sand specified in Section 312000 "Earth Moving."

2.5 ANTIFREEZE SOLUTION

A. Propylene Glycol: Minimum 6 percent propylene glycol with corrosion inhibitors and environmental stabilizer additives to be mixed with water to protect the piping circuit and connected equipment from physical damage from freezing or corrosion.

B. Quantity: Sufficient solution for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

C. Dilution Water: Chloride content shall be less than 25 ppm, sulfate less than 25 ppm, and hardness less than 100 ppm.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, warning tape, and backfilling are specified in Section 312000 "Earth Moving."

3.2 ACCEPTABLE INSTALLERS

A. Installation shall be performed by qualified laborers trained in the procedures of ground loop heat exchange systems and have IGSHPA certification.

3.3 PREPARATION

A. Coordinate with related trades and manufacturer’s recommendations with regard to installation in conjunction with:

1. Drilling
2. Excavation
3. Pipe Fusion
4. Heat Pump Location

3.4 HORIZONTAL PIPING INSTALLATION

A. Separate trenches by 10 feet minimum, unless otherwise indicated. Remove rocks in trenches that could contact pipe.

B. Backfill to 24 inches above pipe with mud developed from excavated rock-free soil or with sand, pea gravel, or fly ash. Backfill from slurry level to grade with excavated soil, compacting as specified for pipe burial in Section 312000 "Earth Moving."

C. Extend pipe from trench onto the bottom of the body of water at an elevation that is at least 12 inches below frost line. Seal membrane or impervious liner under the body of water after installing piping.

D. Install PEXa piping in trenches according to ASTM D 2774 or ASTM F 645.

1. Clean PEXa pipe and fittings and make heat-fusion joints according to ASTM D 2657. Minimize number of joints.

E. Purge, flush, and pressure test piping before backfilling trenches.

F. Install continuous detectable warning tape for underground piping. Locate tape a minimum of 24 inches below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

3.5 VERTICAL PIPING INSTALLATION

A. Install PEXa piping in boreholes according to ASTM D 2774 or ASTM F 645.

1. Clean PEXa pipe and fittings and make heat-fusion joints according to ASTM F1055 or EN 1555-3. Minimize number of joints.

B. Purge, flush, and pressure test piping before backfilling boreholes.

C. After installation of loop pipe in borehole, fill piping loop with water or antifreeze solution, and pump backfill into borehole to discharge at base of borehole.

D. Fill borehole with backfill to a point at least 60 inches below grade and backfill remainder with surface seal material.

E. Extend piping and connect to water-source, ground-loop, heat-pump 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-source, ground-loop, heat-pump piping systems are installed. Terminate piping with caps. Make connections to building water-source, ground-loop, heat-pump piping systems when those systems are installed.

F. Wall sleeves are specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

G. Mechanical sleeve seals are specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

3.6 ANTIFREEZE SOLUTION FILL

A. Fill system with required quantity of propylene glycol and water to provide minus 10 deg F freezing temperature.

B. Test the dilute solution using gas chromatography to verity concentration of propylene glycol, and forward report to Architect.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

3.8 GENERAL INSTALLATION

A. Install in accordance with manufacturer's published installation manual and/or published guidelines and final shop drawings.

B. Mount manifolds in the locations previously prepared or in previously installed cabinets, if used. Manifolds shall be mounted as level as possible, with the venting device on the uppermost section.

C. Route piping in an orderly manner, according to layout and spacing shown in final shop drawings.

D. At connections and fittings, use a plastic pipe cutter to ensure square and clean cuts, and join pipes immediately or cap ends of pipe to seal from contaminants. Where compression-sleeve fittings are installed within the ground, they shall be wrapped in a heat-shrink material approved by the manufacturer.

E. Piping that shall pass through expansion joints shall be covered in protective polyethylene convoluted sleeving (flexible conduit) extending 15 inches on each side of the joint. Sleeving shall be secured on pipe to prevent movement during installation of thermal mass.

F. Where piping exits the thermal mass, a protective conduit shall be placed around the pipe, with the conduit extending a minimum of 6 inches into the floor and exiting by a minimum of 6 inches. For penetrations at manifolds, use rigid PVC bend guides secured in place to prevent movement.

G. At the time of installation of each circuit of pipe, connect the pipe to the correct manifold outlet and record pipe length for balancing. If manifold is not installed, cap the end of the pipe and label the pipe's circuit numbers along with S for supply and R for return. Connect pipes to manifold as soon as possible and record circuit lengths. Circuits shall be labeled to indicate circuit length and serviced area.

3.9 FIELD QUALITY CONTROL

A. Piping Tests: Fill piping 24 hours before testing and apply test pressure to stabilize piping. Use potable water only.

B. Hydrostatic Tests: Test at not less than 1-1/2 times the pipe working-pressure rating allowing for static pressure of borehole depth.

1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 30 minutes. Slowly increase to next test pressure increment and hold for 30 minutes. After testing at maximum test pressure, reduce pressure to 30 psig. Hold for 90 minutes, and measure pressure at 30-minute intervals. Repair leaks and retest until no leaks exist.

C. Prepare reports of testing activity.

END OF SECTION 23 21 14

SECTION 23 21 23 - 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, end-suction centrifugal pumps.
2. Automatic condensate pump units.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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(s) for each pump.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong Pumps Inc.
2. Aurora Pump; Division of Pentair Pump Group.
3. ITT Corporation; Bell & Gossett.
4. PACO Pumps.
5. Patterson
6. TACO Incorporated.
7. Thrush Company Inc.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, 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 and rigidly mounted to pump casing with integral pump support.

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 NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

a. Enclosure: Open, dripproof.
b. Enclosure Materials: Cast iron.

c. Motor Bearings: Permanently lubricated ball bearings.

d. Efficiency: Premium efficient.

2.2 AUTOMATIC CONDENSATE PUMP UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Beckett Corporation.

2. Hartell Pumps Div.; Milton Roy Co.

3. Little Giant Pump Co.

4. Mepco, LLC.

B. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch- minimum, electrical power cord with plug.

2.3 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.

2. 175-psig pressure rating, ductile-iron body and end cap, pump-inlet fitting.

3. Bronze startup and bronze or stainless-steel permanent strainers.

4. Bronze or stainless-steel straightening vanes.

5. Drain plug.

6. Factory-fabricated support.

B. Triple-Duty Valve:

1. Angle or straight pattern.

2. 175-psig pressure rating, ductile-iron body, pump-discharge fitting.

3. Drain plug and bronze-fitted shutoff, balancing, and check valve features.

4. Brass gage ports with integral check valve and orifice for flow measurement.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the 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.

3.3 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps to provide access for periodic maintenance including removing 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.

D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

E. Equipment Mounting: Install base-mounted pumps on cast-in-place concrete equipment base(s) using restrained spring isolators. Comply with requirements for equipment bases specified in Section 033000 "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Minimum Deflection: 1/4 inch.

2. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of concrete base.

4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

6. Install anchor bolts to elevations required for proper attachment to supported equipment.

7. Install on 4-inch- high concrete base.

F. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and elastomeric hangers of size required to support weight of in-line pumps.

1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.4 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. 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.

3.5 CONNECTIONS

A. Where installing piping adjacent to pump, allow space for service and maintenance.

B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

D. Install triple-duty valve on discharge side of pumps.

E. Install suction diffuser and shutoff valve on suction side of pumps.

F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

G. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

H. Install check valve and gate or ball valve on each condensate pump unit discharge.

I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 STARTUP SERVICE

A. Engage a manufacturer factory 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. Clean strainers on suction piping.

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 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 23 21 23

SECTION 23 23 00 - 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 refrigerant piping used for air-conditioning applications.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-134a:

1. Suction Lines for Air-Conditioning Applications: 115 psig.

2. Suction Lines for Heat-Pump Applications: 225 psig.

3. Hot-Gas and Liquid Lines: 225 psig.

B. Line Test Pressure for Refrigerant R-407C:

1. Suction Lines for Air-Conditioning Applications: 230 psig.

2. Suction Lines for Heat-Pump Applications: 380 psig.

3. Hot-Gas and Liquid Lines: 380 psig.

C. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.

2. Suction Lines for Heat-Pump Applications: 535 psig.

3. Hot-Gas and Liquid Lines: 535 psig.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.

2. Solenoid valves.

3. Hot-gas bypass valves.

4. Filter dryers.

5. Strainers.

6. Pressure-regulating valves.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 and MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and MR 5.2: For products regionally manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.9 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type L.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Brazing Filler Metals: AWS A5.8.

E. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.

2. End Connections: Socket ends.

3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.

4. Pressure Rating: Factory test at minimum 500 psig.

5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.

2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.

3. Operator: Rising stem and hand wheel.

4. Seat: Nylon.

5. End Connections: Socket, union, or flanged.

6. Working Pressure Rating: 500 psig.

7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.

2. Packing: Molded stem, back seating, and replaceable under pressure.

3. Operator: Rising stem.

4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.

5. Seal Cap: Forged-brass or valox hex cap.

6. End Connections: Socket, union, threaded, or flanged.

7. Working Pressure Rating: 500 psig.

8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.

2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.

3. Piston: Removable polytetrafluoroethylene seat.

4. Closing Spring: Stainless steel.

5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.

6. End Connections: Socket, union, threaded, or flanged.

7. Maximum Opening Pressure: 0.50 psig.

8. Working Pressure Rating: 500 psig.

9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.

2. Core: Removable ball-type check valve with stainless-steel spring.

3. Seat: Polytetrafluoroethylene.

4. End Connections: Copper spring.

5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.

2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

3. Seat: Polytetrafluoroethylene.

4. End Connections: Threaded.

5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.

6. Working Pressure Rating: 400 psig.

7. Maximum Operating Temperature: 240 deg F.

8. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.

2. Piston, Closing Spring, and Seat Insert: Stainless steel.

3. Seat Disc: Polytetrafluoroethylene.

4. End Connections: Threaded.

5. Working Pressure Rating: 400 psig.

6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.

2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.

3. Packing and Gaskets: Non-asbestos.

4. Capillary and Bulb: Copper tubing filled with refrigerant charge.

5. Suction Temperature: 40 deg F.

6. Superheat: Adjustable.

7. Reverse-flow option (for heat-pump applications).

8. End Connections: Socket, flare, or threaded union.

9. Working Pressure Rating: 450 psig.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.

2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.

3. Packing and Gaskets: Non-asbestos.

4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

5. Seat: Polytetrafluoroethylene.

6. Equalizer: Internal.

7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.

8. End Connections: Socket.

9. Throttling Range: Maximum 5 psig.

10. Working Pressure Rating: 500 psig.

11. Maximum Operating Temperature: 240 deg F.

I. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.

2. Screen: 100-mesh stainless steel.

3. End Connections: Socket or flare.

4. Working Pressure Rating: 500 psig.

5. Maximum Operating Temperature: 275 deg F.

J. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.

2. Drain Plug: Brass hex plug.

3. Screen: 100-mesh monel.

4. End Connections: Socket or flare.

5. Working Pressure Rating: 500 psig.

6. Maximum Operating Temperature: 275 deg F.

K. Moisture/Liquid Indicators:

1. Body: Forged brass.

2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.

3. Indicator: Color coded to show moisture content in ppm.

4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.

5. End Connections: Socket or flare.

6. Working Pressure Rating: 500 psig.

7. Maximum Operating Temperature: 240 deg F.

L. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.

2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.

3. Desiccant Media: Activated alumina.

4. Designed for reverse flow (for heat-pump applications).

5. End Connections: Socket.

6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.

7. Maximum Pressure Loss: 2 psig.

8. Working Pressure Rating: 500 psig.

9. Maximum Operating Temperature: 240 deg F.

M. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.

2. End Connections: Socket or flare.

3. Working Pressure Rating: 500 psig.

4. Maximum Operating Temperature: 275 deg F.

N. Receivers: Comply with ARI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

2. Comply with UL 207; listed and labeled by an NRTL.

3. Body: Welded steel with corrosion-resistant coating.

4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.

5. End Connections: Socket or threaded.

6. Working Pressure Rating: 500 psig.

7. Maximum Operating Temperature: 275 deg F.

O. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.

2. End Connections: Socket or threaded.

3. Working Pressure Rating: 500 psig.

4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Atofina Chemicals, Inc.

2. DuPont Company; Fluorochemicals Div.

3. Honeywell, Inc.; Genetron Refrigerants.

4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-134a: Tetrafluoroethane.

C. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.

D. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 PIPING APPLICATIONS FOR REFRIGERANT R-134a

A. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications

1. NPS 1-1/2 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping:

1. NPS 1-1/2 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.

3.3 PIPING APPLICATIONS FOR REFRIGERANT R-407C

A. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:

1. NPS 4 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping:

1. NPS 4and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.

3.4 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.5 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.

2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.

3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Solenoid valves.

2. Thermostatic expansion valves.

3. Hot-gas bypass valves.

4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.

3.6 PIPING INSTALLATION

A. 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 Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. 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.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence of Operations for HVAC Controls" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.

2. Install horizontal suction lines with a uniform slope downward to compressor.

3. Install traps and double risers to entrain oil in vertical runs.

4. Liquid lines may be installed level.

P. When brazing or soldering, 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.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.7 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.

2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.8 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. 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 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. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. 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.

7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

D. Support multifloor vertical runs at least at each floor.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.

2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.

3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
   a. Fill system with nitrogen to the required test pressure.

b. System shall maintain test pressure at the manifold gage throughout duration of test.
c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.10 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, 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.

3.11 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.

2. Verify that compressor oil level is correct.

3. Open compressor suction and discharge valves.

4. Open refrigerant valves except bypass valves that are used for other purposes.

5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

SECTION 23 25 00 - 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 the following HVAC water-treatment systems:

1. Chemical-feed equipment and controls.

2. HVAC water-treatment chemicals.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

C. TDS: Total dissolved solids.

D. UV: Ultraviolet.

1.4 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment 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. Closed hydronic systems, including hot-water heating and chilled water, shall have the following water qualities:

1. pH: Maintain a value within 9.0 to 10.5.

2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.

3. Boron: Maintain a value within 100 to 200 ppm.

4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.

5. Soluble Copper: Maintain a maximum value of 0.20 ppm.

6. TDS: Maintain a maximum value of 10 ppm.

7. Ammonia: Maintain a maximum value of 20 ppm.

8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.

9. Microbiological Limits:
   a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
   b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
   c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
   d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
   e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

1.5 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:

1. Chemical Feeders.

2. Chemical test equipment.

3. Chemical material safety data sheets.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

B. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.

2. Water Analysis: Illustrate water quality available at Project site.

3. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.

1.7 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

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.

1.8 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for cooling, chilled-water piping, heating, hot-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.

2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.

3. Periodic field service and consultation.

4. Customer report charts and log sheets.

5. Laboratory technical analysis.

6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ampion Corp.

2. Anderson Chemical Co, Inc.

3. Aqua-Chem, Inc.; Cleaver-Brooks Div.

4. Barclay Chemical Co.; Water Management, Inc.

5. Boland Trane Services

6. GE Betz.

7. GE Osmonics.

8. H-O-H Chemicals, Inc.

9. Metro Group. Inc. (The); Metropolitan Refining Div.

10. ONDEO Nalco Company.

11. Watcon, Inc.

2.2 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Water Meter:

1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: 150 psig (1035 kPa).
4. Maximum Pressure Loss at Design Flow: 3 psig (20 kPa).
5. Registration: Gallons (Liters) or cubic feet (cubic meters).
6. End Connections: Flanged.
7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.

B. Inhibitor Injection Timers:

1. Microprocessor-based controller with LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Section 230900 "Instrumentation and Control for HVAC."
2. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
3. Test switch.
4. Hand-off-auto switch for chemical pump.
5. Illuminated legend to indicate feed when pump is activated.
6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
7. LCD makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.

C. pH Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status

indication at central workstation as described in Section 230900 "Instrumentation and Control for HVAC."
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal pH indication.
5. High or low pH alarm light, trip points field adjustable; with silence switch.
6. Hand-off-auto switch for acid pump.
7. Internal adjustable hysteresis or deadband.

D. TDS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Section 230900 "Instrumentation and Control for HVAC."
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal conductance indication.
5. High or low conductance alarm light, trip points field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or deadband.
9. Bleed Valves:

    a. Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.
    b. Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.

E. Biocide Feeder Timer:

1. Microprocessor-based controller with digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Section 230900 "Instrumentation and Control for HVAC."
2. 24-hour timer with 14-day skip feature to permit activation any hour of day.
3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.
4. Solid-state alternator to enable use of two different formulations.
5. 24-hour display of time of day.
6. 14-day display of day of week.
7. Battery backup so clock is not disturbed by power outages.
8. Hand-off-auto switches for biocide pumps.
9. Biocide A and Biocide B pump running indication.

F. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: 50 gal. (189 L).

G. Chemical Solution Injection Pumps:

1. Self-priming, positive-displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

H. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

I. Injection Assembly:

1. Quill: Minimum NPS 1/2 (DN 15) with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: Two-piece, stainless steel as described in "Stainless-Steel Pipes and Fittings" Article below; and selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum 600 psig (4137 kPa) at 200 deg F (93 deg C).

2.3 STAINLESS-STEEL PIPES AND FITTINGS

A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.

B. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.

C. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig SWP and 600-psig CWP ratings.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.3 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Install water testing equipment on wall near water chemical application equipment.

C. Install interconnecting control wiring for chemical treatment controls and sensors.

D. Mount sensors and injectors in piping circuits.

E. Install automatic chemical-feed equipment for condenser water and include the following:
   1. Install water meter in makeup water supply.
   2. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.
      a. Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.
   3. Install test equipment and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   4. Install TDS controller with sensor and bleed valves.
      a. Bleed valves shall cycle to maintain maximum TDS concentration.
   5. Install pH sensor and controller with injection pumps and solution tanks.
      a. Injector pumps shall operate to maintain required pH.
   6. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.
      a. Injection pumps shall operate to feed biocide on an alternating basis.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232113 "Hydronic Piping."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523 "General-Duty Valves for HVAC Piping."

E. Refer to Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.

F. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

G. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.

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.

4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.

5. 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.

6. 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.

7. 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.

8. Repair leaks and defects with new materials and retest piping until no leaks exist.

D. Remove and replace malfunctioning units and retest as specified above.

E. Sample condenser water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article for each required characteristic. Sample condenser water at **six**-week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.

F. At **six**-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.

G. Comply with ASTM D 3370 and with the following standards:

1. Silica: ASTM D 859.

2. Steam System: ASTM D 1066.

3. Acidity and Alkalinity: ASTM D 1067.

4. Iron: ASTM D 1068.

5. Water Hardness: ASTM D 1126.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Section 017900 "Demonstration and Training."

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

END OF SECTION 23 25 00

SECTION 23 31 13 - 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 the following:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Double-wall round ducts and fittings.
4. Sheet metal materials.
5. Duct liner.
6. Sealants and gaskets.
7. Hangers and supports.

B. Related Sections:

1. Division 01 Section “Construction Waste Management”
2. Division 01 Section "LEED Requirements" for additional LEED requirements.
3. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
4. Section 233119 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
5. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.

2. Sealants and gaskets.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."

4. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-up."

5. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

6. Laboratory Test Reports for Credit IEQ 4: For adhesives and 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."

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.

2. Factory- and shop-fabricated ducts and fittings.

3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.

4. Elevation of top of ducts.

5. Dimensions of main duct runs from building grid lines.

6. Penetrations through fire-rated and other partitions.

7. Equipment installation based on equipment being used on Project.

8. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

9. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: 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. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.

2. Suspended ceiling components.

3. Structural members to which duct will be attached.

4. Size and location of initial access modules for acoustical tile.

5. Penetrations of smoke barriers and fire-rated construction.

6. Items penetrating finished ceiling including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. Perimeter moldings.

B. Welding certificates.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.

3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Lindab Inc.

2. McGill AirFlow LLC.

3. SEMCO Incorporated.

4. Sheet Metal Connectors, Inc.

5. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 DOUBLE-WALL ROUND DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.
4. Sheet Metal Connectors, Inc.

B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of 23 percent.

D. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at75 deg F mean temperature.

2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" 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: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.

2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. 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.

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.5 DUCT LINER

A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Aeroflex USA Inc.
   b. Armacell LLC.
   c. Rubatex International, LLC

2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
   a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Adhesive 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. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

3. Butt transverse joints without gaps, and coat joint with adhesive.

4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.

6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.

7. 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.

8. 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:
   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.
   c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
   a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. 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.

2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.

2. Solids Content: Minimum 65 percent.

3. Shore A Hardness: Minimum 20.

4. Water resistant.

5. Mold and mildew resistant.

6. VOC: Maximum 75 g/L (less water).

7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.

8. Service: Indoor or outdoor.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.

2. Type: S.

3. Grade: NS.

4. Class: 25.

5. Use: O.

6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. 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."

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg static-pressure class, positive or negative.

2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.3 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.4 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.

B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches from bottom of duct.

C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.5 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2. Outdoor, Supply-Air Ducts: Seal Class A.

3. Outdoor, Exhaust Ducts: Seal Class C.

4. Outdoor, Return-Air Ducts: Seal Class C.

5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.

6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.

7. Unconditioned Space, Exhaust Ducts: Seal Class C.

8. Unconditioned Space, Return-Air Ducts: Seal Class B.

9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.

10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.

11. Conditioned Space, Exhaust Ducts: Seal Class B.

12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.

2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.7 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.8 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.

2. Test the following systems:
   a. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
   b. Supply Ducts downstream of VAV box: Test representative duct sections totaling no less than 25 percent of total installed duct area.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

4. Test for leaks before applying external insulation.

5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.

6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
   a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.10 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.

2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.

4. Coils and related components.

5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.

6. Supply-air ducts, dampers, actuators, and turning vanes.

7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.

4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.11 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.12 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
   a. Pressure Class: Positive 1-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Variable-Air-Volume Air-Handling Units:
   a. Pressure Class: Positive 3-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 3.
   d. SMACNA Leakage Class for Round and Flat Oval: 3.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
   a. Pressure Class: Positive or negative 1-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
   a. Pressure Class: Negative 1-inch wg.
   b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
   a. Exposed to View: Type 304, stainless-steel sheet, No. 3 finish.
   b. Concealed: Type 304, stainless-steel sheet, No. 2D finish.

c. Welded seams and joints.
d. Pressure Class: Positive or negative 2-inch wg.
e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
f. SMACNA Leakage Class: 3.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
   a. Pressure Class: Positive or negative 1-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

2. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

G. Liner:

1. Supply Air Ducts: Flexible elastomeric, 1 inch thick.

2. Return Air Ducts: Flexible elastomeric, 1 inch thick.

H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Velocity 1000 fpm or Lower:
      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      2) Mitered Type RE 4 without vanes.
   b. Velocity 1000 to 1500 fpm:
      1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
   c. Velocity 1500 fpm or Higher:
      1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
      4) Radius-to Diameter Ratio: 1.5.
   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
   a. Velocity 1000 fpm or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm: Conical tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 13

SECTION 23 33 00 - 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. Manual volume dampers.
2. Control dampers.
3. Fire dampers.
4. Flange connectors.
5. Duct silencers.
6. Turning vanes.
7. Remote damper operators.
8. Duct-mounted access doors.
9. Flexible connectors.
10. Flexible ducts.
11. Duct accessory hardware.

B. Related Requirements:

1. Division 01 Section “Construction Waste Management”
2. Division 01 Section "LEED Requirements" for additional LEED requirements.
3. Section 283111 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.
4. Section 283100 "Fire Detection and Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

2. Submit laboratory acoustic and aerodynamic performance obtained according to ASTM E477-13 and so certified when submitted for approval. The laboratory must be currently NVLAP accredited for the ASTM E477-13 test standard. A copy of the accreditation certificate must be included with the submittals. Data from non-NVLAP accredited test facilities will not be accepted. Shop drawings submitted without proper certifications will be rejected.
   a. Submitted silencer pressure drops shall not exceed those listed in the silencer schedule. Silencer pressure drop measurements shall be made in accordance with the ASTM E477-13 test standard. Tests shall be conducted and reported on the identical units for which acoustical data is presented.
   b. Silencer dynamic insertion loss shall not be less than that listed in the silencer schedule.
   c. Silencer generated noise shall not be greater than that listed in the silencer schedule

3. The silencer manufacturer shall provide, for approval, acoustical system calculations for all duct systems with silencers to demonstrate that the submitted silencers will reduce mechanical fan noise to NC 30 in the occupied space. Use sound power levels of actual equipment to be installed on project. Analysis shall include breakout noise calculations. In the absence of specified background sound level criteria, the guidelines as expressed in Table 34 of Chapter 47, “Sound and Vibration Control” of the *2003 ASHRAE Handbook - HVAC Applications*, shall be used.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

2. Product Data for Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Silencer performance must have been substantiated by laboratory testing in a duct-to-reverberant room test facility according to ASTM E477-13.The test facility must provide for airflow in both directions through the test silencer. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption. The aero-acoustic laboratory must be currently NVLAP accredited for the ASTM E477-13 test standard.

C. Silencer manufacturer shall provide a written test report by a third party organization showing silencer assemblies have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84, NFPA 255 or UL 723.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

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. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" 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.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.

2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 MANUAL VOLUME DAMPERS

A. Low-Leakage, Aluminum, Manual Volume Dampers:

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. Air Balance Inc.; a division of Mestek, Inc.
   b. American Warming and Ventilating; a division of Mestek, Inc.
   c. McGill AirFlow LLC.
   d. Nailor Industries Inc.
   e. Pottorff.
   f. Ruskin Company.
   g. Trox USA Inc.
   h. Vent Products Company, Inc.

2. Comply with AMCA 500-D testing for damper rating.

3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

4. Suitable for horizontal or vertical applications.

5. Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.

6. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design. (for dampers 13 inches and larger in height with maximum blade width of 6 inches)
   c. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
   d. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.

7. Blade Axles: Galvanized steel.

8. Bearings:
   a. Oil-impregnated bronze.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

9. Blade Seals: Neoprene.

10. Jamb Seals: Cambered aluminum.

11. Tie Bars and Brackets: Aluminum.

12. Accessories:
    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

B. Jackshaft:

1. Size: 0.5-inch diameter.

2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. 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.

2. Include center hole to suit damper operating-rod size.

3. Include elevated platform for insulated duct mounting.

2.4 CONTROL DAMPERS

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. American Warming and Ventilating; a division of Mestek, Inc.

2. Arrow United Industries; a division of Mestek, Inc.

3. Cesco Products; a division of Mestek, Inc.

4. Greenheck Fan Corporation.

5. Lloyd Industries, Inc.

6. McGill AirFlow LLC.

7. Metal Form Manufacturing, Inc.

8. Nailor Industries Inc.

9. NCA Manufacturing, Inc.

10. Pottorff.

11. Ruskin Company.

12. Vent Products Company, Inc.

13. Young Regulator Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. Hat shaped.

2. 0.094-inch- thick, galvanized sheet steel.

3. Mitered and welded corners.

D. Blades:

1. Multiple blade with maximum blade width of 6 inches.

2. Parallel- and opposed-blade design.

3. Galvanized-steel.

4. 0.064 inch thick single skin.

5. Blade Edging: Closed-cell neoprene.

6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

E. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:

1. Oil-impregnated bronze.

2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

3. Thrust bearings at each end of every blade.

2.5 FIRE DAMPERS

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. Air Balance Inc.; a division of Mestek, Inc.

2. Arrow United Industries; a division of Mestek, Inc.

3. Cesco Products; a division of Mestek, Inc.

4. Greenheck Fan Corporation.

5. Nailor Industries Inc.

6. NCA Manufacturing, Inc.

7. Pottorff.

8. Prefco; Perfect Air Control, Inc.

9. Ruskin Company.

10. Vent Products Company, Inc.

11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Type: Static; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.05 thick, as indicated, and of length to suit application.

2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.024-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.6 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.

2. Nexus PDQ; Division of Shilco Holdings Inc.

3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.7 DUCT SILENCERS

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. Dynasonics.

2. Semco

3. Vibro-Acoustics.

B. General Requirements:

1. Factory fabricated.

2. Silencers shall be of the size, configuration, capacity and acoustic performance as scheduled on the drawings. All silencers shall be factory fabricated and supplied by the same manufacturer.
3. Silencer inlet and outlet connection dimensions must be equal to the duct sizes shown on the drawings. Duct transitions at silencers are not permitted unless shown on the contract drawings.
4. Silencers shall be constructed in accordance with ASHRAE and SMACNA standards for the pressure and velocity classification specified for the air distribution system in which it is installed. Material gauges noted in other sections are minimums. Material gauges shall be increased as required for the system pressure and velocity classification. The silencers shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge.
5. All casing seams and joints shall be lock-formed and sealed or stitch welded and sealed except as noted in Section G below, to provide leakage-resistant construction. Airtight construction shall be achieved by use of a duct-sealing compound supplied and installed by the contractor at the jobsite.

6. All perforated steel shall be adequately stiffened to insure flatness and form. All spot welds shall be painted.
7. Fire-Performance Characteristics: Silencer assemblies, including acoustic media fill and sealants shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84, NFPA 255 or UL 723.
8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.

C. Shape:

1. Rectangular straight with splitters or baffles.

2. Round straight with center bodies or pods.

3. Rectangular elbow with splitters or baffles.

4. Round elbow with center bodies or pods.

5. Rectangular transitional with splitters or baffles.

D. Rectangular Silencers including models RD and EXRD: Outer casing shall be ASTM A 653/A 653M, G90 galvanized sheet steel, 22 gauge.

E. Rectangular Elbow Silencers including model RED: Outer casing shall be ASTM A 653/A 653M, G90 galvanized sheet steel, 22 gauge minimum. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48” shall have at least two half splitters and one full splitter.

F. Round Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel.

1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 0.034 inch thick.

2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 0.040 inch thick.

3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 0.05 inch thick.

4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 0.064 inch thick.

G. Inner perforated metal liner: ASTM A 653/A 653M, G90 galvanized sheet steel.

1. Rectangular Silencers: 26 gauge.
2. Rectangular Elbow Silencers: 22 gauge.

H. Connection Sizes: Match connecting ductwork unless otherwise indicated.

I. Principal Sound-Absorbing Mechanism:

1. Dissipative silencers:

a. Models RD, RED and EXRD type with acoustic media. Media shall be of acoustic quality, shot-free glass fiber insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall be as required to insure conformance with laboratory test data. Glass fiber shall be packed with a minimum of 15% compression during silencer assembly. Media shall be resilient such that it will not crumble or break, and conform to irregular surfaces. Media shall not cause or accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for glass fiber.

J. HTL Casings: Where indicated on the silencer schedule, silencers shall have high transmission loss (HTL) walls externally applied and completely sealed to the silencer casing by the silencer manufacturer to assure quality controlled transmission loss. The HTL walls shall consist of media, airspace, mass and outer protective metal skin, as required, to obtain the specified room noise criteria. Standard acoustical panels will not be accepted as HTL walls. If requested by the Engineer, breakout noise calculations for each air handling and fan system shall be provided with the silencer submittal to insure compliance with the room noise criteria. Breakout noise calculations shall be based on the sound power levels of the specified equipment.

K. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

1. Joints: Lock formed and sealed.

2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.

3. Reinforcement: Cross or trapeze angles for rigid suspension.

L. Accessories:

1. Integral 1-1/2-hour fire damper with access door. Access door to be high transmission loss to match silencer.

2. Factory-installed end caps to prevent contamination during shipping.

3. Removable splitters.

4. Airflow measuring devices.

M. Source Quality Control: Test according to ASTM E 477.

1. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.

2. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

2.8 TURNING VANES

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. Ductmate Industries, Inc.

2. Duro Dyne Inc.

3. Elgen Manufacturing.

4. METALAIRE, Inc.

5. SEMCO Incorporated.

6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single wall.

2.9 DUCT-MOUNTED ACCESS DOORS

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. American Warming and Ventilating; a division of Mestek, Inc.

2. Cesco Products; a division of Mestek, Inc.

3. Ductmate Industries, Inc.

4. Elgen Manufacturing.

5. Flexmaster U.S.A., Inc.

6. Greenheck Fan Corporation.

7. McGill AirFlow LLC.

8. Nailor Industries Inc.

9. Pottorff.

10. Ventfabrics, Inc.

11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.
   d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.

2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.

3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.

4. Factory set at 3.0- to 8.0-inch wg.

5. Doors close when pressures are within set-point range.

6. Hinge: Continuous piano.

7. Latches: Cam.

8. Seal: Neoprene or foam rubber.

9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.10 DUCT ACCESS PANEL ASSEMBLIES

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. Ductmate Industries, Inc.

2. Flame Gard, Inc.

3. 3M.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.

D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.11 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.

2. Duro Dyne Inc.

3. Elgen Manufacturing.

4. Ventfabrics, Inc.

5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 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. Provide metal compatible with connected ducts.

E. 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 40 to plus 200 deg F.

F. 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 50 to plus 250 deg F.

G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.

2. Outdoor 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. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.12 FLEXIBLE DUCTS

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. Flexmaster U.S.A., Inc.

2. McGill AirFlow LLC.

3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; [polyethylene] [aluminized] vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.

2. Maximum Air Velocity: 4000 fpm.

3. Temperature Range: Minus 10 to plus 160 deg F.

4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:

1. 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.

2.13 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 thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install 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 control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.

2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire dampers according to UL listing.

H. Connect ducts to duct silencers rigidly.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.

2. Upstream from duct filters.

3. At outdoor-air intakes and mixed-air plenums.

4. At drain pans and seals.

5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.

6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.

7. At each change in direction and at maximum 50-foot spacing.

8. Upstream from turning vanes.

9. Upstream or downstream from duct silencers.

10. Control devices requiring inspection.

11. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:

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.

L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

P. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

Q. Connect flexible ducts to metal ducts with draw bands.

R. Install duct test holes where required for testing and balancing purposes.

S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.

3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.

4. Inspect turning vanes for proper and secure installation.

5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

SECTION 23 34 23 - 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. Centrifugal roof ventilators.

2. Upblast propeller roof exhaust fans.

3. In-line centrifugal fans.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also 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 thickness and finishes, including color charts.

5. Dampers, including housings, linkages, and operators.

6. Roof curbs.

7. Fan speed controllers.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set(s) for each belt-driven unit.

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. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.8 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Engineering & Manufacturing Corporation.

2. Greenheck Fan Corporation.

3. JencoFan.

4. Loren Cook Company.

5. PennBarry.

6. Twin City

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.

2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt Drives:

1. Resiliently mounted to housing.

2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

4. Pulleys: Cast-iron, adjustable-pitch motor pulley.

5. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.

3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

F. Roof Curbs: Galvanized steel; 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 roof opening and fan base.

1. Configuration: Built-in raised cant and mounting flange.

2. Overall Height: 24 inches.

3. Sound Curb: Curb with sound-absorbing insulation.

4. Pitch Mounting: Manufacture curb for roof slope.

5. Metal Liner: Galvanized steel.

6. Mounting Pedestal: Galvanized steel with removable access panel.

7. Vented Curb: Unlined with louvered vents in vertical sides.

2.2 UPBLAST PROPELLER ROOF EXHAUST FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Engineering & Manufacturing Corporation.

2. Greenheck Fan Corporation.

3. JencoFan.

4. Loren Cook Company.

5. PennBarry.

6. Twin City

B. Wind Band, Fan Housing, and Base: Reinforced and braced aluminum, containing aluminum butterfly dampers and rain trough, motor and drive assembly, and fan wheel.

1. Damper Rods: Steel with bronze bearings.

2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheel: Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

D. Belt Drives:

1. Resiliently mounted to housing.

2. Weatherproof housing of same material as fan housing.

3. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

4. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.

5. Pulleys: Cast-iron, adjustable-pitch motor pulley.

6. Motor Mount: On outside of fan cabinet, adjustable base for belt tensioning.

E. Roof Curbs: Galvanized steel; 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 roof opening and fan base.

1. Configuration: Built-in raised cant and mounting flange.

2. Overall Height: 24 inches.

3. Sound Curb: Curb with sound-absorbing insulation.

4. Pitch Mounting: Manufacture curb for roof slope.

5. Metal Liner: Galvanized steel.

6. Mounting Pedestal: Galvanized steel with removable access panel.

2.3 IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Engineering & Manufacturing Corporation.

2. Greenheck Fan Corporation.

3. JencoFan.

4. Loren Cook Company.

5. PennBarry.

6. Twin City

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

D. 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.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.

3. Companion Flanges: For inlet and outlet duct connections.

4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.

5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Totally enclosed, fan cooled.

2.5 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to 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. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.

D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

E. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

F. Install units with clearances for service and maintenance.

G. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.3 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

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. Tests and Inspections:

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. Adjust belt tension.

6. Adjust damper linkages for proper damper operation.

7. Verify lubrication for bearings and other moving parts.

8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.

10. Shut unit down and reconnect automatic temperature-control operators.

11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 23 34 23

SECTION 23 37 13 - 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 the following:

1. Rectangular and square ceiling diffusers.

2. Perforated diffusers.

3. Linear slot diffusers.

4. Drum louvers.

5. Adjustable bar registers and grilles.

B. Related Sections:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

3. Section 089000 "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.

4. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of 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 noise ratings.

2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 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 assembly members.

2. Method of attaching hangers to building structure.

3. Size and location of initial access modules for acoustical tile.

4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hart & Cooley Inc.
   b. Krueger.
   c. METALAIRE, Inc.
   d. Nailor Industries Inc.
   e. Price Industries.
   f. Titus.

2. Devices shall be specifically designed for variable-air-volume flows.

3. Material: Steel.

4. Finish: Baked enamel, white.

5. Face Size: 24 by 24 inches.

6. Mounting: T-bar.

7. Pattern: Adjustable.

8. Dampers: Radial opposed blade.

9. Accessories:
   a. Equalizing grid.

b. Plaster ring.
c. Safety chain.
d. Wire guard.
e. Sectorizing baffles.
f. Operating rod extension.

B. Perforated Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hart & Cooley Inc.
   b. Krueger.
   c. METALAIRE, Inc.
   d. Nailor Industries Inc.
   e. Price Industries.
   f. Titus.

2. Devices shall be specifically designed for variable-air-volume flows.

3. Material: Steel backpan and pattern controllers, with steel face.

4. Finish: Baked enamel, white.

5. Face Size: 24 by 24 inches.

6. Duct Inlet: Round.

7. Face Style: Flush

8. Mounting: T-bar.

9. Pattern Controller: Fixed with curved blades at inlet.

10. Dampers: Opposed blade.

11. Accessories:
    a. Equalizing grid.
    b. Plaster ring.
    c. Safety chain.
    d. Wire guard.
    e. Sectorizing baffles.
    f. Operating rod extension.

2.2 HIGH-CAPACITY DIFFUSERS

A. Drum Louver:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hart & Cooley Inc.

b. Krueger.
c. METALAIRE, Inc.
d. Nailor Industries Inc.
e. Price Industries.
f. Titus.

2. Airflow Principle: Extended distance for high airflow rates.

3. Material: Aluminum, heavy gage extruded.

4. Finish: White baked acrylic.

5. Border: 1-1/4-inch width with countersunk screw holes.

6. Gasket between drum and border.

7. Body: Drum shaped; adjustable vertically.

8. Blades: Individually adjustable horizontally.

9. Mounting: Surface to duct.

10. Accessories:
a. Opposed-blade steel damper.
b. Duct-mounting collars with countersunk screw holes.

2.3 REGISTERS AND GRILLES

A. Fixed Face Register:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Hart & Cooley Inc.
b. Krueger.
c. METALAIRE, Inc.
d. Nailor Industries Inc.
e. Price Industries.
f. Titus.

2. Material: Steel.

3. Finish: Baked enamel, white.

4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.

5. Core Construction: Removable.

6. Frame: 1-1/4 inches wide.

7. Mounting: Countersunk screw.

8. Damper Type: Adjustable opposed blade.

9. Accessory: Filter.

B. Fixed Face Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hart & Cooley Inc.
   b. Krueger.
   c. METALAIRE, Inc.
   d. Nailor Industries Inc.
   e. Price Industries.
   f. Titus.

2. Material: Steel.

3. Finish: Baked enamel, white.

4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.

5. Core Construction: Removable.

6. Frame: 1-1/4 inches wide.

7. Mounting: Countersunk screw.

8. Accessory: Filter.

2.4 CEILING LINEAR SLOT OUTLETS

A. Linear Slot Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Air Research Diffuser Products, Inc.
   b. Hart & Cooley Inc.
   c. Price Industries.
   d. Titus.
   e. Tuttle & Bailey.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material - Shell: Aluminum, insulated.
4. Material - Pattern Controller and Tees: Aluminum.
5. Finish - Face and Shell: Baked enamel, black.
6. Finish - Pattern Controller: Baked enamel, black.
7. Finish - Tees: Baked enamel, white.

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 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 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.

3.3 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-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 practical. 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.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.4 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

SECTION 23 38 13 - COMMERCIAL-KITCHEN HOODS

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 Type I commercial kitchen hoods.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 DEFINITIONS

A. Listed Hood: A hood, factory fabricated and tested for compliance with UL 710 by a testing agency acceptable to authorities having jurisdiction.

B. Standard Hood: A hood, usually field fabricated that complies with design, construction, and performance criteria of applicable national and local codes.

C. Type I Hood: A hood designed for grease exhaust applications.

D. Type II Hood: A hood designed for heat and steam removal and for other nongrease applications.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Standard hoods.

2. Filters/baffles.

3. Fire-suppression systems.

4. Lighting fixtures.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.

1. Shop Drawing Scale: 1/4 inch = 1 foot.

2. Show plan view, elevation view, sections, roughing-in dimensions, service requirements, duct connection sizes, and attachments to other work.

3. Show cooking equipment plan and elevation to confirm minimum code-required overhang.

4. Indicate performance, exhaust and makeup air airflow, and pressure loss at actual Project-site elevation.

5. Show water-supply and drain piping connections.

6. Show control cabinets.

7. Show fire-protection cylinders, piping, actuation devices, and manual control devices.

8. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

9. Design Calculations: Calculate requirements for selecting seismic restraints.

10. Wiring Diagrams: Power, signal, and control wiring.

11. Piping Diagrams: Detail fire-suppression piping and components and differentiate between manufacturer-installed and field-installed piping. Include roughing-in requirements for drain connections. Show cooking equipment plan and elevation to illustrate fire-suppression nozzle locations.
    a. Piping Diagram Scale: 1/4 inch = 1 foot.

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, based on input from installers of the items involved:

1. Coordination Drawing Scale: 1/4 inch = 1 foot.

2. Suspended ceiling assembly components.

3. Structural members to which equipment will be attached.

4. Roof framing and support members for duct penetrations.

5. Items penetrating finished ceiling, including the following:
    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.

d. Sprinklers.
e. Access panels.
f. Moldings on hoods and accessory equipment.

B. Welding certificates.

C. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D 1.1M, "Structural Welding Code - Steel," for hangers and supports; and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for joint and seam welding.

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. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 COORDINATION

A. Coordinate equipment layout and installation with adjacent Work, including lighting fixtures, HVAC equipment, plumbing, and fire-suppression system components.

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. Furnish one complete set(s) of grease filters/baffles.

PART 2 - PRODUCTS

2.1 HOOD MATERIALS

A. Stainless-Steel Sheet: ASTM A 666, Type 304.

1. Minimum Thickness: 0.037 inch.

2. Finish: Comply with SSINA's "Finishes for Stainless Steel" for recommendations for applying and designating finishes.
   a. Finish shall be free from tool and die marks and stretch lines and shall have uniform, directionally textured, polished finish indicated, free of cross scratches. Grain shall run with long dimension of each piece.

3. Concealed Stainless-Steel Surfaces: ASTM A 480/A 480M, No. 2B finish (bright, cold-rolled, unpolished finish).

4. Exposed Surfaces: ASTM A 480/A 480M, No. 3 finish (intermediate polished surface).

5. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Sealant: ASTM C 920; Type S, Grade NS, Class 25, Use NT. Elastomeric sealant shall be NSF certified for commercial kitchen hood application. Sealants, when cured and washed, shall comply with requirements in 21 CFR, Section 177.2600, for use in areas that come in contact with food.

1. Color: As selected by Architect from manufacturer's full range.

2. Backer Rod: Closed-cell polyethylene, in diameter larger than joint width.

C. Sound Dampening: NSF-certified, nonabsorbent, hard-drying, sound-deadening compound for permanent adhesion to metal in minimum 1/8-inch thickness that does not chip, flake, or blister.

D. Gaskets: NSF certified for end-use application indicated; of resilient rubber, neoprene, or PVC that is nontoxic, stable, odorless, nonabsorbent, and unaffected by exposure to foods and cleaning compounds, and that passes testing according to UL 710.

2.2 GENERAL HOOD FABRICATION REQUIREMENTS

A. Welding: Use welding rod of same composition as metal being welded. Use methods that minimize distortion and develop strength and corrosion resistance of base metal. Make ductile welds free of mechanical imperfections such as gas holes, pits, or cracks.

1. Welded Butt Joints: Full-penetration welds for full-joint length. Make joints flat, continuous, and homogenous with sheet metal without relying on straps under seams, filling in with solder, or spot welding.

2. Grind exposed welded joints flush with adjoining material and polish to match adjoining surfaces.

3. Where fasteners are welded to underside of equipment, finish reverse side of weld smooth and flush.

4. Coat concealed stainless-steel welded joints with metallic-based paint to prevent corrosion.

B. For metal butt joints, comply with SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."

C. Where stainless steel is joined to a dissimilar metal, use stainless-steel welding material or fastening devices.

D. Form metal with break bends that are not flaky, scaly, or cracked in appearance; where breaks mar uniform surface appearance of material, remove marks by grinding, polishing, and finishing.

E. Sheared Metal Edges: Finish free of burrs, fins, and irregular projections.

F. In food zones, as defined in NSF, fabricate surfaces free from exposed fasteners.

G. Cap exposed fastener threads, including those inside cabinets, with stainless-steel lock washers and stainless-steel cap (acorn) nuts.

H. Fabricate pipe slots on equipment with turned-up edges sized to accommodate service and utility lines and mechanical connections.

I. Fabricate enclosures, including panels, housings, and skirts, to conceal service lines, operating components, and mechanical and electrical devices including those inside cabinets, unless otherwise indicated.

J. Fabricate equipment edges and backsplashes according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."

K. Fabricate enclosure panels to ceiling and wall as follows:

1. Fabricate panels on all exposed side(s) with same material as hood, and extend from ceiling to top of hood canopy and from canopy to wall.

2. Wall Offset Spacer: Minimum of 3 inches.

3. Wall Shelves and Overshelves: Fabricate according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines," with minimum 0.0625-inch- thick, stainless-steel shelf tops.

2.3 TYPE I EXHAUST HOOD FABRICATION

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Aerolator Systems, Inc.

2. AHR Metals, Inc.; Air Saver Systems.

3. Air Tech; Delfield Company (The).

4. AyrKing Corporation.

5. Captive-Aire Systems.

6. Carroll Manufacturing International.

7. Duke Manufacturing Company.

8. Gaylord Industries, Inc.

9. Giles Enterprises, Inc.

10. Grease Master; a division of Custom Industries, Inc.

11. Greenheck.

12. Halton Company.

13. LCSystems, Inc.

14. Sturdi-Bilt Restaurant Equipment.

15. Vent Master; Div. of Garland Commercial Ranges, Ltd.

B. Weld all joints exposed to grease with continuous welds, and make filters/baffles or grease extractors and makeup air diffusers easily accessible for cleaning.

1. Fabricate hoods according to NSF 2, "Food Equipment."

2. Hoods shall be listed and labeled, according to UL 710, by a testing agency acceptable to authorities having jurisdiction.

3. Hoods shall be designed, fabricated, and installed according to NFPA 96.

4. Include access panels as required for access to fire dampers and fusible links.

5. Duct-Collar Fire Dampers: Collar and damper shall comply with UL 710 testing and listing required for the entire hood.
   a. Collar: Minimum 0.0598-inch- thick stainless steel, at least 3 inches long, continuously welded to top of hood and at corners. Fabricate a collar with a minimum 0.5-inch- wide duct flange.
   b. Blades: Minimum 0.1046-inch- thick stainless steel, counterbalanced to remain closed after actuation.
   c. Blade Pivot and Spring: Stainless steel.
   d. Fusible Link: Replaceable, 212 deg F rated.

6. Makeup Air Fire Dampers: Labeled, according to UL 555, by a testing agency acceptable to authorities having jurisdiction.
   a. Fire Rating: 1-1/2 hours.
   b. Frame: SMACNA Type A, with blades in airstream; fabricated with roll-formed, stainless steel; with mitered and interlocking corners.
   c. Blades: Roll-formed, interlocking or folded, minimum 0.034-inch- thick, galvanized-steel sheet.

d. Horizontal Dampers: Include a blade lock and stainless-steel closure spring.
e. Fusible Link: Replaceable, 212 deg F rated.

C. Hood Configuration: Exhaust only.

1. Makeup air shall be introduced through laminar-flow-type, perforated metal diffusers mounted in the ceiling in front of hood canopy. Furnish laminar-flow-type diffusers with baked white enamel finish and volume-control dampers.

D. Hood Style: Wall-mounted canopy.

E. Filters/Baffles: Removable, stainless-steel, with spring-loaded fastening. Fabricate stainless steel for filter frame and removable collection cup and pitched trough. Exposed surfaces shall be pitched to drain to collection cup. Filters/baffles shall be tested according to UL 1046, "Grease Filters for Exhaust Ducts," by an NRTL acceptable to authorities having jurisdiction.

F. Removable Water-Wash Grease Extractor: Stainless steel, tested with hood according to UL 710.

G. Lighting Fixtures: Recessed, fluorescent fixtures and lamps with lenses sealed vaportight. Wiring shall be installed in conduit on hood exterior. Number and location of fixtures shall provide a minimum of 70 fc at 30 inches above finished floor.

1. Light switches shall be mounted on front panel of hood canopy.

2. Lighting Fixtures: Fluorescent complying with UL 1598.

H. Comply with requirements in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls" for hood controls.

I. Hood Controls: Hood-mounting control cabinet, factory wired to control groups of adjacent hoods, and fabricated of stainless steel.

1. Exhaust Fan: On-off switches shall start and stop the exhaust fan. Interlock exhaust fan with makeup air supply fan to operate simultaneously. Interlock exhaust fan with fire-suppression system to operate fan(s) during fire-suppression-agent release and to remain in operation until manually stopped. Include red pilot light to indicate fan operation. Motor starters shall comply with Division 26 Section "Enclosed Controllers."

2. Exhaust Fan Interlock: Factory wire the exhaust fan starters in a single control cabinet for adjacent hoods to operate together.

3. High-Temperature Control: Alarm shall sound and cooking equipment shall shut down before hood discharge temperature rises to actuation temperature of fire-suppression system.

2.4 WET-CHEMICAL FIRE-SUPPRESSION SYSTEM

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ansul Incorporated; a Tyco International Ltd. Company.

2. Badger Fire Protection.

3. Kidde Fire Systems.

4. Pyro Chem.

B. Description: Engineered distribution piping designed for automatic detection and release or manual release of fire-suppression agent by hood operator. Fire-suppression system shall be listed and labeled for complying with NFPA 17A, "Wet Chemical Extinguishing Systems," by a qualified testing agency acceptable to authorities having jurisdiction.

1. Steel Pipe, NPS 2 and Smaller: ASTM A 53/A 53M, Type S, Grade A, Schedule 40, plain ends.

2. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.

3. Piping, fusible links and release mechanism, tank containing the suppression agent, and controls shall be factory installed. Controls shall be in stainless-steel control cabinet mounted on hood or wall. Furnish manual pull station for wall mounting. Exposed piping shall be covered with chrome-plated aluminum tubing. Exposed fittings shall be chrome plated.

4. Liquid Extinguishing Agent: Noncorrosive, low-pH liquid.

5. Furnish electric-operated gas shutoff valve; refer to Division 23 Section "Facility Natural-Gas Piping."

6. Furnish electric-operated gas shutoff valve with clearly marked open and closed indicator for field installation.

7. Fire-suppression system controls shall be integrated with controls for fans, lights, and fuel supply and located in a single cabinet for each group of hoods immediately adjacent.

8. Wiring shall have color-coded, numbered terminal blocks and grounding bar. Spare terminals for fire alarm, optional wiring to start fan with fire alarm, red pilot light to indicate fan operation, and control switches shall all be factory wired in control cabinet with relays or starters. Include spare terminals for fire alarm, and wiring to start fan with fire alarm.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Complete field assembly of hoods where required.

1. Make closed butt and contact joints that do not require filler.

2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in Part 2 "General Hood Fabrication Requirements" Article.

B. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, filters/baffles, grease extractor, and fire-suppression systems according to manufacturer's written instructions and requirements of authorities having jurisdiction.

C. Make cutouts in hoods where required to run service lines and to make final connections, and seal openings according to UL 1978.

D. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners, unless otherwise indicated.

E. Install hoods to operate free from vibration.

F. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches o.c. maximum.

G. Install sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.

H. Install lamps, with maximum recommended wattage, in equipment with integral lighting.

I. Set initial temperatures, and calibrate sensors.

J. Set field-adjustable switches.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping with clearance to allow service and maintenance.

C. Install reduced-pressure backflow preventer on washer-water supply. Backflow preventer is specified in Division 22 Section "Domestic Water Piping Specialties."

D. Install washer-water drain piping full size of hood connection to an adjacent floor drain or floor sink.

E. Makeup Water Connection: Comply with applicable requirements in Division 22 Section "Domestic Water Piping Specialties" for valves and accessories on piping connections to water-cooled units.

F. Connect ducts according to requirements in Division 23 Section "Air Duct Accessories." Install flexible connectors on makeup air supply duct. Weld exhaust-duct connections with continuous liquidtight joint.

G. Install fire-suppression piping for remote-mounted suppression systems according to NFPA 17A, "Wet Chemical Extinguishing Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. 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.

D. Tests and Inspections:

1. Test each equipment item for proper operation. Repair or replace equipment that is defective, including units that operate below required capacity or that operate with excessive noise or vibration.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Test water, drain, gas, and liquid-carrying components for leaks. Repair or replace leaking components.

4. Perform hood performance tests required by authorities having jurisdiction.

5. Perform fire-suppression system performance tests required by authorities having jurisdiction.

E. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial kitchen hoods. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 38 13

SECTION 237333 - INDOOR INDIRECT-FUEL-FIRED HEATING AND VENTILATING 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 indirect-fired H&V units with the following accessories:

1. **Gas** furnace.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, and methods of field assembly, components, and location and size of each field connection. Prepare the following by or under the supervision of a qualified professional engineer:

1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
2. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. 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.
4. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof-mounted units and roof-curb mounting details 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. Size and location of rooftop unit mounting rails and anchor points and methods for anchoring units to curb.
2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.

B. Startup service reports.

C. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For indirect-fired H&V units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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: One set(s) for each unit.
2. Fan Belts: One set(s) for each unit.

1.7 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of indirect-fired H&V units and are based on the specific system indicated. Refer to Section 016000 "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. Comply with NFPA 70.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Coordinate size, location, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

C. Coordinate size, location and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.

1. Coordinate installation of restrained vibration isolation roof-curb rails, which are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below of indirect-fired H&V units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AbsolutAire, Inc.
2. Advanced Climate Technologies, Inc.
3. Air Dynamics Co.
4. Air Economy Corp.
5. Applied Air; Mestek, Inc.
6. ARES; Mars Air Products.
7. Bananza Air Management Systems Inc.; Div. of Rapid Engineering, Inc.
8. BessamAire, Inc.
9. Cambridge Engineering, Inc.
10. E. K. Campbell Co.; Mechanical Products Division of Thomas & Betts Corporation.
11. Captive-Air Systems, Inc.
12. CES Group; Ventrol Air Handling Systems, Inc.
13. Des Champs Laboratories Incorporated; a unit of Entrodyne Corporation.
14. Energy Jet U.S.
15. Engineered Air.
16. Greenheck.
17. Hastings Industries; Division of Eric, Inc.
18. Industrial Commercial Engineering.
19. Jackson & Church; Div. of Donlee Technologies Inc.
20. KING.
21. LC Systems.
22. Modine Mfg. Co.; Commercial HVAC&R Division.
23. Powrmatic, Inc.
24. Rapid Engineering, Inc.
25. Reznor-Thomas & Betts Corporation; Mechanical Products Division.

26. Sterling Gas; Mestek, Inc.
27. Temprite; Mestek, Inc.
28. Titan Air Incorporated.
29. Trane Company (The); Unitary Products Group.
30. Weather-Rite, Inc.

2.2 PACKAGED UNITS

A. Factory-assembled, prewired, self-contained unit consisting of cabinet, supply fan, controls, filters, and indirect-fired gas furnace to be installed outside the building.

2.3 CABINET

A. Cabinet: Double-wall galvanized-steel panels, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs. Cabinet shall be fully weatherized for outside installation.

B. Access Panels: Piano hinged with cam-lock fasteners for furnace and fan motor assemblies on both sides of unit.

C. Internal Insulation: Fibrous-glass duct lining, comply with ASTM C 1071, Type II, applied on furnace and fan sections only.

1. Thickness: 1 inch (25 mm).
2. Insulation Adhesive: Comply with ASTM C 916, Type I.
3. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner when applied as recommended by manufacturer and without causing air leakage.

D. Finish: Heat-resistant, baked enamel.

E. Roof Curb: Full-perimeter curb of sheet metal, minimum 24 inches high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.

F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.4 SUPPLY-AIR FAN

A. Fan Type: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel shaft with heavy-duty, self-aligning, permanently lubricated ball bearings.

B. Motor: Open dripproof, single-speed motor.

C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly.

D. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with spring isolators.

2.5 OUTDOOR-AIR INTAKE

A. Outdoor-Air Hood: Galvanized steel with rain baffles, bird screen complying with ASHRAE 62.1, and finish to match cabinet; and sized to supply maximum 100 percent outdoor air.

2.6 AIR FILTERS

A. Comply with NFPA 90A.

B. Cleanable Filters: 2-inch- (50-mm-) thick, cleanable metal mesh.

2.7 DAMPERS

A. Outdoor-Air Damper: Galvanized-steel, opposed-blade dampers with vinyl blade seals and stainless-steel jamb seals, having a maximum leakage of 10 cfm/sq. ft. (51 L/s per sq. m) of damper area, at differential pressure of 2-inch wg (448 Pa).

B. Damper Operator: Direct coupled, electronic with spring return or fully modulating as required by the control sequence.

2.8 INDIRECT-FIRED GAS FURNACE

A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47, "Gas-Fired Central Furnaces," and NFPA 54, "National Fuel Gas Code."

1. AGA Approval: Designed and certified by and bearing label of AGA.
2. Burners: Aluminized steel with stainless-steel inserts.

a. Gas Control Valve: Modulating.
b. Fuel: Natural gas.
c. Minimum Combustion Efficiency: 80 percent.
d. Ignition: Electronically controlled electric spark with flame sensor.

B. Venting: Gravity vented.

C. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.

D. Combustion-Air Intake: Separate combustion-air intake and vent terminal assembly.

E. Inside Unit External Housing: Steel cabinet with integral support inserts and removable bottom arranged to serve as drain pan.

F. Outside Unit External Housing: Weatherproof steel cabinet with integral support inserts and removable bottom arranged to serve as drain pan.

1. External Casing and Cabinet Finish: Baked enamel over corrosion-resistant-treated surface in color to match fan section.

G. Internal Casing: Aluminized steel, arranged to contain airflow, with duct flanges at inlet and outlet.

H. Heat Exchanger: Stainless steel.

I. Heat-Exchanger Drain Pan: Stainless steel.

J. Safety Controls:

1. Vent Flow Verification: Differential pressure switch to verify open vent.
2. Control Transformer: 24-V ac.
3. High Limit: Thermal switch or fuse to stop burner.
4. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, electronic-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
5. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
6. Gas Manifold: Safety switches and controls to comply with ANSI standards.
7. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
8. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
9. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

2.9 CONTROLS

A. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.

B. Control Panel: Surface-mounted remote panel, with engraved plastic cover, and the following lights and switches:

1. On-off-auto fan switch.
2. Summer-winter-off switch. Automatic changeover.
3. Supply-fan operation indicating light.
4. Heating operation indicating light.
5. Thermostat.
6. Damper position potentiometer.
7. Cooling operation indicating light.
8. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
9. Safety-lockout indicating light.

C. Refer to Section 230900 "Instrumentation and Control for HVAC" for control equipment and sequence of operation.

D. Control Devices:

1. Remote Thermostat: Adjustable room thermostat with temperature readout.

2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
3. Fire-Protection Thermostats: Fixed or adjustable settings to operate at not less than 75 deg F (24 deg C) above normal maximum operating temperature.
4. Timers: Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.
5. Ionization-Type Smoke Detectors: 24-V dc, nominal; self-restoring; plug-in arrangement; integral visual-indicating light; sensitivity that can be tested and adjusted in place after installation; integral addressable module; remote controllability; responsive to both visible and invisible products of combustion; self-compensating for changes in environmental conditions.

E. Fan Control: Interlock fan to start with exhaust fan(s).

F. Fan Control: Timer starts and stops indirect-fired H&V unit and exhaust fan(s).

1. Fan-Discharge Thermostat: Stops fan on burner failure when outdoor-air temperature is less than 40 deg F (4 deg C).
2. Smoke detectors, located in supply air, shall stop fans when the presence of smoke is detected.

G. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.

H. Temperature Control: Operates gas valve to maintain supply-air temperature.

1. Operates gas valve to maintain discharge-air temperature with factory-mounted sensor in blower outlet.
2. Furnace Control: 20 to 100 percent modulation of the firing rate. 10 to 100 percent with dual furnace units.

I. DDC: Stand-alone control module for link between unit controls and DDC system. Control module shall be compatible with temperature-control system specified in Section 230900 "Instrumentation and Control for HVAC."

1. Provide start and stop interface relay, and relay to notify DDC system alarm condition.
2. Provide hardware interface or additional sensors as follows:

a. Room temperature.
b. Discharge-air temperature.
c. Furnace operating.

2.10 MOTORS

A. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation of indirect-fired H&V units.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where rooftop replacement-air units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."

B. Install roof curb on roof structure, according to ARI Guideline B. Install and secure indirect-fired H&V units on curbs, and coordinate roof penetrations and flashing with roof construction.

C. Install controls and equipment shipped by manufacturer for field installation with indirect-fired H&V units.

3.3 CONNECTIONS

A. Piping Connections: Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.

1. Gas Piping: Comply with requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Provide AGA-approved flexible connectors.

B. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply ducts to indirect-fired H&V units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 STARTUP SERVICE

A. Engage a manufacturer factory service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for visible damage to furnace combustion chamber.
2. Inspect casing insulation for integrity, moisture content, and adhesion.
3. Verify that clearances have been provided for servicing.
4. Verify that controls are connected and operable.
5. Verify that filters are installed.
6. Purge gas line.
7. Inspect and adjust vibration isolators.
8. Verify bearing lubrication.
9. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
10. Adjust fan belts to proper alignment and tension.
11. Start unit according to manufacturer's written instructions.
12. Complete startup sheets and attach copy with Contractor's startup report.
13. Inspect and record performance of interlocks and protective devices; verify sequences.
14. Operate unit for run-in period recommended by manufacturer.
15. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:

    a. Gas Burner:

        1) Measure gas pressure at manifold.
        2) Measure combustion-air temperature at inlet to combustion chamber.
        3) Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

16. Calibrate thermostats.
17. Adjust and inspect high-temperature limits.
18. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.

19. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
20. Measure and record airflow. Plot fan volumes on fan curve.
21. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:

    a. High-limit heat.
    b. Alarms.

22. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace malfunctioning components that do not pass tests and inspections and retest as specified above.

D. Prepare written report of the results of startup services.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a manufacturer factory service representative to train Owner's maintenance personnel to adjust, operate, and maintain indirect-fired H&V units. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 237333

SECTION 23 74 13 - OUTDOOR, CENTRAL-STATION 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes outdoor, central-station air-handling units (rooftop units) with the following components and accessories:

1. Water-source heat pump refrigeration components.
2. Hot-gas reheat.
3. Total Energy Wheel
4. Economizer outdoor- and return-air damper section.
5. Integral, space temperature controls.
6. Roof curbs.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”
2. Division 01 Section "LEED Requirements" for additional LEED requirements.
3. Section 237433 "Dedicated Outdoor-Air Units" for outdoor equipment air conditioning 100 percent outdoor air to replace air exhausted from a building.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electrically commutated motor.

C. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

D. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design RTU supports to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Wind-Restraint Performance:

1. Minimum 10 lb/sq. ft multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

1.5 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. LEED Submittals:

1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.

2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

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. Wiring Diagrams: Power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which RTUs will be attached.

2. Roof openings

3. Roof curbs and flashing.

B. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force 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. Field quality-control test reports.

D. Warranty: Special warranty specified in this Section.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

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 Belts: One set for each belt-driven fan.

2. Filters: One set of filters for each unit.

1.9 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.

2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.

2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. 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.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

2. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Trane; American Standard Companies, Inc.

2. YORK International Corporation.

3. Carrier Corporation.

4. McQuay International.

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

1. Exterior Casing Thickness: 0.052 inch thick.

C. Inner Casing Fabrication Requirements:

1. Inside Casing: Galvanized steel, 0.034 inch thick.

D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.

2. Thickness: 2 inch.

3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.

4. Liner Adhesive: Comply with ASTM C 916, Type I.

E. Inspection and Access Panels and Access Doors:

1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.

2. Inspection and Access Panels:
   a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
   b. Gasket: Neoprene, applied around entire perimeters of panel frames.
   c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

3. Access Doors:
   a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
   b. Gasket: Neoprene, applied around entire perimeters of panel frames.
   c. Fabricate windows in fan section doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
   d. Size: At least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.

4. Locations and Applications:
   a. Fan Section: Inspection and access panels.
   b. Access Section: Doors.
   c. Coil Section: Inspection and access panel.
   d. Damper Section: Inspection and access panels.
   e. Filter Section: Inspection and access panels large enough to allow periodic removal and installation of filters.
   f. Mixing Section: Doors.
   g. Humidifier Section: Doors.

5. Service Light: 100-W vaporproof fixture with switched junction box located inside adjacent to door.

F. Condensate Drain Pans: Formed sections of galvanized-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.

2. Drain Connections: Threaded nipple.

3. Pan-Top Surface Coating: Corrosion-resistant compound.

G. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.3 FANS

A. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

C. Relief-Air Fan: Backward inclined, shaft mounted on permanently lubricated motor.

A. Fan Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment." Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.

2. Horizontal-Flanged, Split Housing: Bolted construction.

3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.

4. Flexible Connector: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized-steel sheet or 0.032-inch- thick aluminum sheets; select metal compatible with casing.
   a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
      1) Fabric Minimum Weight: 26 oz./sq. yd..
      2) Fabric Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
      3) Fabric Service Temperature: Minus 40 to plus 200 deg F.

B. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.

C. Fan Shaft Bearings:

1. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with a rated life of 200,000 hours according to ABMA 9.

2. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing with grease lines extended to outside unit.

D. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.2 service factor based on fan motor.

1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

2. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5-hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

3. Belts: Oil resistant, nonsparking, and nonstatic; in matched sets for multiple-belt drives.

4. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.1046-inch- thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.

E. Discharge Dampers: Heavy-duty steel assembly with channel frame and sealed ball bearings, and opposed blades constructed of two plates formed around and welded to shaft, with blades linked out of air stream to single control lever.

F. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.

G. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Totally enclosed, fan cooled.

2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.

3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

5. Mount unit-mounted disconnect switches on exterior of unit.

H. Variable Frequency Controllers:

1. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

2. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

3. Unit Operating Requirements:
   a. Minimum Efficiency: 96 percent at 60 Hz, full load.
   b. Minimum Displacement Primary-Side Power Factor: 96 percent.
   c. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
   d. Starting Torque: 100 percent of rated torque or as indicated.
   e. Speed Regulation: Plus or minus 1 percent.

4. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

5. Internal Adjustability Capabilities:
   a. Minimum Speed: 5 to 25 percent of maximum rpm.
   b. Maximum Speed: 80 to 100 percent of maximum rpm.
   c. Acceleration: 2 to a minimum of 22 seconds.
   d. Deceleration: 2 to a minimum of 22 seconds.
   e. Current Limit: 50 to a minimum of 110 percent of maximum rating.

6. Self-Protection and Reliability Features:
   a. Input transient protection by means of surge suppressors.
   b. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
   c. Adjustable motor overload relays capable of NEMA ICS 2, **Class 10** performance.
   d. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
   e. Instantaneous line-to-line and line-to-ground overcurrent trips.
   f. Loss-of-phase protection.
   g. Reverse-phase protection.
   h. Short-circuit protection.
   i. Motor overtemperature fault.

7. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

8. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

9. 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.

10. 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.

11. Door-mounted LED status lights shall indicate the following conditions:
    a. Power on.
    b. Run.
    c. Overvoltage.
    d. Line fault.
    e. Overcurrent.
    f. External fault.

12. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual-speed-control potentiometer and elapsed time meter.

13. Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
    a. Output frequency (Hertz).
    b. Motor speed (rpm).
    c. Motor status (running, stop, fault).
    d. Motor current (amperes).
    e. Motor torque (percent).
    f. Fault or alarming status (code).
    g. Proportional-integral-derivative (PID) feedback signal (percent).
    h. DC-link voltage (volts direct current).
    i. Set-point frequency (Hertz).
    j. Motor output voltage (volts).

14. Control Signal Interface:
    a. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
    b. Remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:
        1) 0 to 10-V dc.
        2) 0-20 or 4-20 mA.
        3) Potentiometer using up/down digital inputs.
        4) Fixed frequencies using digital inputs.
        5) RS485.
        6) Keypad display for local hand operation.
    c. Output signal interface with a minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
        1) Output frequency (Hertz).
        2) Output current (load).
        3) DC-link voltage (volts direct current).
        4) Motor torque (percent).
        5) Motor speed (rpm).
        6) Set-point frequency (Hertz).
    d. Remote indication interface with a minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
        1) Motor running.
        2) Set-point speed reached.

3) Fault and warning indication (overtemperature or overcurrent).
4) High- or low-speed limits reached.

15. Communications: RS485 interface allows VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

16. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

17. Accessories:
    a. Devices shall be factory installed in controller enclosure unless otherwise indicated.
    b. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
    c. Standard Displays:
        1) Output frequency (Hertz).
        2) Set-point frequency (Hertz).
        3) Motor current (amperes).
        4) DC-link voltage (volts direct current).
        5) Motor torque (percent).
        6) Motor speed (rpm).
        7) Motor output voltage (volts).

2.4 WATER-SOURCE HEAT PUMP

A. Water Circuit:

1. Refrigerant-to-Water Heat Exchanger:

    a. Coil-in-shell heat exchanger with copper water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube leak tested to 450 psig on refrigerant side and 400 psig on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
    b. Stainless-steel brazed plate heat exchanger leak tested to 450 psig on refrigerant side and 400 psig on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.

2. Water Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger, and control head pressure on compressor during cooling and heating. Valves shall close when heat-pump compressor is not running.

3. Motorized Water Valve: Stop water flow through the unit when compressor is off.

B. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to 450 psig.

C. Refrigerant Circuit Components:

1. Sealed Refrigerant Circuit: Minimum of 2 circuits required for units 10 tons and larger. Intertwine circuits in refrigerant to air coil.

   a. Charge with R-410A refrigerant.

2. Filter-Dryer: Factory installed to clean and dehydrate each refrigerant circuit.

3. Charging Connections: Service fittings on suction and liquid for charging and testing on each circuit.

4. Reversing Valve: Pilot-operated sliding-type valve designed to be fail-safe in heating position with replaceable magnetic coil.

5. Compressor: [Hermetic reciprocating] [Hermetic scroll] [Semihermetic reciprocating] compressor installed on vibration isolators housed in an acoustically treated enclosure with factory-installed safeties as follows:

   a. Antirecycle timer.
   b. High-pressure cutout.
   c. Low-pressure cutout or loss of charge switch.
   d. Internal thermal-overload protection.
   e. Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below 35 deg F.
   f. Condensate overflow switch to stop compressor with high condensate level in condensate drain pan.

6. Refrigerant Piping Materials: ASTM B 743 copper tube with wrought-copper fittings and brazed joints.

7. Pipe Insulation: Refrigerant minimum 3/8-inch- thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-development indexes per ASTM E 84.

8. Refrigerant Metering Device: Capillary tube.

9. Refrigerant Metering Device: Thermal expansion valve to allow specified operation with entering-water temperatures from 25 to 125 deg F.

10. Hot-Gas Reheat Valve: Pilot-operated sliding-type valve with replaceable magnetic coil.

D. Hot-Gas Reheat: Reheat valve diverts refrigerant hot gas to reheat coil when remote humidistat calls for dehumidification.

E. Hot-Gas Bypass: Include constant pressure expansion valve, solenoid valve, and controls to maintain continuous refrigeration system operation at 10 percent of full load on lead compressor.

F. Outdoor-Air Damper: Linked damper blades, for minimum 25 percent outdoor air, with fully modulating, spring-return damper motor and hood.

G. Air-Side Economizer: Return-, relief-, and outdoor-air dampers with neoprene seals and with weather-resistant hood.

1. Damper Motors: Fully modulating spring return with adjustable minimum position potentiometer.

2. Temperature Control: Microprocessor-based controller using outdoor-air, mixed-air temperature and selects between outdoor-air and return-air enthalpy to adjust mixing dampers with water-loop entering temperature greater than 70 deg F. Delay opening outdoor-air damper to minimum position until room thermostat is satisfied at room set-point temperature.

3. Relief Damper: Gravity-actuated damper with bird screen and hood.

4. Powered Relief: Direct-drive propeller fan with PSC motor, normally closed motorized damper, and hood. Operate fan with building pressure greater than 0.05-inch wg.

2.5 TOTAL ENERGY WHEEL

A. The rotating wheel heat exchanger is composed of a rotating cylinder in an insulated cassette frame complete with seals, drive motor, and drive belt. The total energy recovery wheel is coated with silica gel desiccant permanently bonded by a patented and proprietary process without the use of binders or adhesives, which may degrade desiccant performance. The substrate is a lightweight polymer and will nt degrade. Coated segments are washable with detergent or alkaline coil cleaner and water. Desiccant will not dissolve nor deliquesce in the presence of water or high humidity. As the wheel rotates between the ventilation and exhaust air streams it picks up sensible and latent heat energy and releases it into the colder air stream. Bypass dampers will be provided on both the outside and exhaust air paths.

2.6 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated: Minimum MERV 13.

2.7 DAMPERS

A. Outdoor-Air Damper: Linked damper blades, for 0 to 100 percent outdoor air, with **motorized** damper filter.

B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.

2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.8 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.9 CONTROLS

A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC."

B. Basic Unit Controls:

1. Control-voltage transformer.

2. Wall-mounted thermostat or sensor with the following features:
   a. Heat-cool-off switch.
   b. Fan on-auto switch.
   c. Fan-speed switch.
   d. Automatic changeover.
   e. Adjustable deadband.
   f. Unoccupied-period-override push button.
   g. Data entry and access port to input temperature and humidity set points, occupied and unoccupied periods, and output room temperature and humidity, supply-air temperature, operating mode, and status.

3. Wall-mounted humidistat or sensor with the following features:
   a. Concealed set point.

4. Remote Wall-Mounted Annunciator Panel for Each Unit:
   a. Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
   b. DDC controller or programmable timer and interface with HVAC instrumentation and control system.
   c. Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.

C. DDC Controller:

1. Controller shall have volatile-memory backup.

2. Safety Control Operation:
   a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.

b. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Section 283111 "Digital, Addressable Fire-Alarm System" and Section 283112 "Zoned (DC Loop) Fire-Alarm System."
c. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than 40 deg F.
d. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.

3. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of two programmable periods per day.

4. Unoccupied Period:
a. Heating Setback: 10 deg F.
b. Cooling Setback: System off.
c. Override Operation: Two hours.

5. Supply Fan Operation:
a. Occupied Periods: Run fan continuously.
b. Unoccupied Periods: Cycle fan to maintain setback temperature.

6. Refrigerant Circuit Operation:

a. Occupied Periods: Cycle or stage compressors, and operate hot-gas bypass to match compressor output to cooling load to maintain room temperature and humidity. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
b. Unoccupied Periods: Cycle compressors and condenser fans for heating to maintain setback temperature.
c. Switch reversing valve for heating or cooling mode on air-to-air heat pump.

7. Hot-Gas Reheat-Coil Operation:

a. Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles compressor.
b. Unoccupied Periods: Reheat not required.

8. Economizer Outdoor-Air Damper Operation:

a. Occupied Periods: Open to fixed minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F. Use outdoor-air enthalpy to adjust mixing dampers. Start relief-air fan with end switch on outdoor-air damper. During economizer cycle operation, lock out cooling.
b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
c. Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor shall adjust for temperature, and output shall range from 2- to 10-V dc.

D. Interface Requirements for HVAC Instrumentation and Control System:

1. Interface relay for scheduled operation.

2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.

3. Provide BACnet compatible interface for central HVAC control workstation for the following:
   a. Adjusting set points.
   b. Monitoring supply fan start, stop, and operation.
   c. Inquiring data to include outdoor-air damper position, supply- and room-air temperature and humidity.
   d. Monitoring occupied and unoccupied operations.
   e. Monitoring constant and variable motor loads.
   f. Monitoring variable-frequency drive operation.
   g. Monitoring cooling load.
   h. Monitoring economizer cycles.
   i. Monitoring air-distribution static pressure and ventilation air volume.

2.10 ACCESSORIES

A. Electric heater with integral thermostat maintains minimum 50 deg F temperature in gas burner compartment.

B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

C. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

D. Coil guards of painted, galvanized-steel wire.

E. Hail guards of galvanized steel, painted to match casing.

F. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

2.11 ROOF CURBS

A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   a. Materials: ASTM C 1071, Type I or II.
   b. Thickness: 1 inch.

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
   a. Liner Adhesive: Comply with ASTM C 916, Type I.

b. 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 cabinet.
c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
d. Liner Adhesive: Comply with ASTM C 916, Type I.

C. Curb Height: 24 inches.

D. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment" for wind-load requirements.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Roof Curb: Install on roof structure or concrete base, level and secure, according to ARI Guideline B. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

B. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

C. Install wind and seismic restraints according to manufacturer's written instructions.

3.4 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

B. Install piping adjacent to RTUs to allow service and maintenance.

C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.

2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.

3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."

4. Install return-air duct continuously through roof structure.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

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. Report results in writing.

C. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.

2. Inspect for and remove shipping bolts, blocks, and tie-down straps.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.6 STARTUP SERVICE

A. Engage a manufacturer factory service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.

2. Inspect for visible damage to furnace combustion chamber.

3. Inspect for visible damage to compressor, coils, and fans.

4. Inspect internal insulation.

5. Verify that labels are clearly visible.

6. Verify that clearances have been provided for servicing.

7. Verify that controls are connected and operable.

8. Verify that filters are installed.

9. Clean condenser coil and inspect for construction debris.

10. Clean furnace flue and inspect for construction debris.

11. Connect and purge gas line.

12. Remove packing from vibration isolators.

13. Inspect operation of barometric relief dampers.

14. Verify lubrication on fan and motor bearings.

15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.

16. Adjust fan belts to proper alignment and tension.

17. Start unit according to manufacturer's written instructions.
    a. Start refrigeration system.
    b. Do not operate below recommended low-ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.

18. Inspect and record performance of interlocks and protective devices; verify sequences.

19. Operate unit for an initial period as recommended or required by manufacturer.

20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
    a. Measure gas pressure on manifold.
    b. Inspect operation of power vents.
    c. Measure combustion-air temperature at inlet to combustion chamber.
    d. Measure flue-gas temperature at furnace discharge.
    e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

21. Calibrate thermostats.

22. Adjust and inspect high-temperature limits.

23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.

24. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

25. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outdoor-air intake volume.

26. Simulate maximum cooling demand and inspect the following:
    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

27. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
    a. High-temperature limit on gas-fired heat exchanger.
    b. Low-temperature safety operation.
    c. Filter high-pressure differential alarm.
    d. Economizer to minimum outdoor-air changeover.
    e. Relief-air fan operation.
    f. Smoke and firestat alarms.

28. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.7 CLEANING AND ADJUSTING

A. 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 site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.8 DEMONSTRATION

A. Engage a manufacturer factory service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 74 13

SECTION 23 74 33 - DEDICATED OUTDOOR-AIR 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 factory-packaged units capable of supplying up to 100 percent outdoor air and providing cooling and heating.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. LEED Submittals:

1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1.

2. Product Data for Prerequisite EA 3: Documentation indicating that refrigerants comply.

3. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.

4. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

5. Product Data for Credit IEQ 1: Documentation indicating that units are equipped with a direct outdoor airflow-measuring device capable of measuring the minimum outdoor airflow with accuracy within 15 percent of the design minimum airflow rate, as defined by ASHRAE 62.1.

6. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

7. Product Data for Credit IEQ 5: Documentation indicating that units include MERV 13 filters rated according to ASHRAE 52.2.

C. Shop Drawings:

1. Include plans, elevations, sections, 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. Prepare the following by or under the supervision of a qualified professional engineer:
   a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
   b. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof-curb mounting 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. Size and location of unit-mounted rails and anchor points and methods for anchoring units to roof curb.

2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.

B. Startup service reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-driven fan.

2. Filters: One set for each unit.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Five years from date of Substantial Completion.

2. Warranty Period for Heat Exchangers: 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. Trane

2. XeteX

3. Aaon

4. Mammoth

5. Munters

2.2 PERFORMANCE REQUIREMENTS

A. General Fabrication Requirements: Comply with requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."

B. Cabinet Thermal Performance:

1. Maximum Overall U-Value: Comply with requirements in ASHRAE/IESNA 90.1.

2. Include effects of metal-to-metal contact and thermal bridges in the calculations.

C. Cabinet Surface Condensation:

1. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.

2. Portions of cabinet located downstream from the cooling coil shall have a thermal break at each thermal bridge between the exterior and interior casing to prevent condensation from occurring on the interior and exterior surfaces. The thermal break shall not compromise the structural integrity of the cabinet.

D. Maximum Cabinet Leakage: 0.5 percent of the total supply-air flow at a pressure rating equal to the fan shut-off pressure.

E. Cabinet Deflection Performance:

1. Walls and roof deflection shall be within 1/200 of the span at the design working pressure equal to the fan shut-off pressure. Deflection limits shall be measured at any point on the surface.

2. Floor deflections shall be within 1/240 of the span considering the worst-case condition caused by the following:
   a. Service personnel.
   b. Internal components.
   c. Design working pressure defined for the walls and roof.

F. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

A. Construction: double wall.

B. Exterior Casing Material: Galvanized steel with paint finish.

C. Interior Casing Material: Galvanized steel.

D. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.

E. Base Rails: Galvanized-steel rails for mounting on roof curb or pad as indicated.

F. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.

1. Service Doors: Hinged access doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.

G. Roof: Standing seam or membrane; sloped to drain water.

H. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.

I. Cabinet Insulation:

1. Type: Fibrous-glass duct lining complying with ASTM C 1071, Type II or flexible elastomeric insulation complying with ASTM C 534, Type II, sheet materials.

2. Thickness: 2 inches.

3. Insulation Adhesive: Comply with ASTM C 916, Type I.

4. Mechanical Fasteners: Suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.

J. Condensate Drain Pans:

1. Shape: Rectangular, with 2 percent slope in at least two planes to direct water toward drain connection.

2. Size: Large enough to collect condensate from cooling coils including coil piping connections, coil headers, and return bends.
   a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
   b. Depth: A minimum of 2 inches deep.

3. Configuration: Double wall, with space between walls filled with foam insulation and moisture-tight seal.

4. Material: Galvanized-steel sheet with asphaltic waterproofing compound coating on pan top surface.

5. Material: Stainless-steel sheet.

6. Drain Connection:
   a. Located on one end of pan, at lowest point of pan.
   b. Terminated with threaded nipple.
   c. Minimum Connection Size: NPS 1.

7. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

K. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.

L. Roof Curb: Full-perimeter curb of sheet metal, minimum 36 inches high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.

1. Comply with requirements in "The NRCA Roofing Manual."

2.4 SUPPLY FAN

A. Plenum Fan Type: Single width, non-overloading, with backward-inclined or airfoil blades.

1. Fan Wheel Material: Aluminum; attached directly to motor shaft.

2. Fan Wheel Drive and Arrangement: Direct drive, AMCA Arrangement 4.

3. Fan panel and frame Material: Powder-coated steel, stainless steel, or aluminum.

4. Fan Enclosure: Easily removable enclosure around rotating parts.

5. Fan Balance: Precision balance fan below 0.08 inch/s at design speed with filter in.

B. Service Factor for Belt Drive Applications: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.4 service factor.

C. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

2. Enclosure: Totally enclosed.

3. Enclosure Materials: Cast aluminum.

4. Efficiency: Premium efficient.

5. Service Factor: 1.0.

D. Mounting: Fan wheel, motor, and drives shall be mounted to fan casing with spring isolators.

2.5 WATER-SOURCE HEAT PUMP

A. Water Circuit:

1. Refrigerant-to-Water Heat Exchanger:

a. Coil-in-shell heat exchanger with copper water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube leak tested to 450 psig on refrigerant side and 400 psig on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
b. Stainless-steel brazed plate heat exchanger leak tested to 450 psig on refrigerant side and 400 psig on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.

2. Water Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger, and control head pressure on compressor during cooling and heating. Valves shall close when heat-pump compressor is not running.
3. Motorized Water Valve: Stop water flow through the unit when compressor is off.

B. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to 450 psig.

C. Refrigerant Circuit Components:

1. Sealed Refrigerant Circuit: Minimum of 2 circuits required for units 10 tons and larger. Intertwine circuits in refrigerant to air coil.

a. Charge with R-410A refrigerant.

2. Filter-Dryer: Factory installed to clean and dehydrate each refrigerant circuit.
3. Charging Connections: Service fittings on suction and liquid for charging and testing on each circuit.

4. Reversing Valve: Pilot-operated sliding-type valve designed to be fail-safe in heating position with replaceable magnetic coil.
5. Compressor: Hermetic scroll compressor installed on vibration isolators housed in an acoustically treated enclosure with factory-installed safeties as follows:

    a. Antirecycle timer.
    b. High-pressure cutout.
    c. Low-pressure cutout or loss of charge switch.
    d. Internal thermal-overload protection.
    e. Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below 35 deg F.
    f. Condensate overflow switch to stop compressor with high condensate level in condensate drain pan.

6. Refrigerant Piping Materials: ASTM B 743 copper tube with wrought-copper fittings and brazed joints.
7. Pipe Insulation: Refrigerant minimum 3/8-inch- thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-development indexes per ASTM E 84.
8. Refrigerant Metering Device: Capillary tube.
9. Refrigerant Metering Device: Thermal expansion valve to allow specified operation with entering-water temperatures from 25 to 125 deg F.
10. Hot-Gas Reheat Valve: Pilot-operated sliding-type valve with replaceable magnetic coil.

D. Hot-Gas Reheat: Reheat valve diverts refrigerant hot gas to reheat coil when remote humidistat calls for dehumidification.

E. Hot-Gas Bypass: Include constant pressure expansion valve, solenoid valve, and controls to maintain continuous refrigeration system operation at 10 percent of full load on lead compressor.

F. Outdoor-Air Damper: Linked damper blades, for minimum 25 percent outdoor air, with fully modulating, spring-return damper motor and hood.

G. Air-Side Economizer: Return-, relief-, and outdoor-air dampers with neoprene seals and with weather-resistant hood.

1. Damper Motors: Fully modulating spring return with adjustable minimum position potentiometer.
2. Temperature Control: Microprocessor-based controller using outdoor-air, mixed-air temperature and selects between outdoor-air and return-air enthalpy to adjust mixing dampers with water-loop entering temperature greater than 70 deg F. Delay opening outdoor-air damper to minimum position until room thermostat is satisfied at room set-point temperature.
3. Relief Damper: Gravity-actuated damper with bird screen and hood.
4. Powered Relief: Direct-drive propeller fan with PSC motor, normally closed motorized damper, and hood. Operate fan with building pressure greater than 0.05-inch wg.

2.6 OUTDOOR-AIR INTAKE HOOD

A. Type: Manufacturer's standard hood or louver.

B. Materials: Match cabinet.

C. Bird Screen: Comply with requirements in ASHRAE 62.1.

D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.7 TOTAL ENERGY WHEEL

A. The rotating wheel heat exchanger is composed of a rotating cylinder in an insulated cassette frame complete with seals, drive motor, and drive belt. The total energy recovery wheel is coated with silica gel desiccant permanently bonded by a patented and proprietary process without the use of binders or adhesives, which may degrade desiccant performance. The substrate is a lightweight polymer and will nt degrade. Coated segments are washable with detergent or alkaline coil cleaner and water. Desiccant will not dissolve nor deliquesce in the presence of water or high humidity. As the wheel rotates between the ventilation and exhaust air streams it picks up sensible and latent heat energy and releases it into the colder air stream. Bypass dampers will be provided on both the outside and exhaust air paths.

2.8 FILTERS

A. Cleanable Filters: 2-inch- thick, cleanable metal mesh.

B. Disposable Panel Filters:

1. Comply with NFPA 90A.

2. Factory-fabricated, viscous-coated, flat-panel type.

3. Thickness: 2 inches.

4. Minimum Merv: 13, according to ASHRAE 52.2.

5. Media: Interlaced glass fibers sprayed with nonflammable adhesive.

C. Extended-Surface, Nonsupported-Media Filters:

1. Comply with NFPA 90A.

2. Factory-fabricated, dry, extended-surface, self-supporting type.

3. Minimum Merv: 13, according to ASHRAE 52.2.

4. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions.

D. Mounting Frames:

1. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.

2. Extended surface filters arranged for flat orientation, removable from access plenum.

3. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

2.9 ELECTRICAL POWER CONNECTIONS

A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.

B. Enclosure: NEMA 250, Type 4X, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key,

C. Wiring: Numbered and color-coded to match wiring diagram.

D. Wiring Location: Install factory wiring outside an enclosure in a raceway.

E. Power Interface: Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch.

F. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:

1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.

2. NEMA KS 1, heavy-duty, nonfusible switch.

3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

G. Factory-Mounted, Overcurrent-Protection Service: For each motor.

H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

I. Controls: Factory wire unit-mounted controls where indicated.

J. Lights: Factory wire unit-mounted lights.

K. Receptacle: Factory wire unit-mounted, ground fault interrupt (GFI) duplex receptacle.

L. Control Relays: Auxiliary and adjustable time-delay relays.

2.10 CONTROLS

A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC."

B. Control Wiring: Factory wire connection for controls' power supply.

C. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.

D. Unit-Mounted Status Panel:

1. Cooling/Off/Heating Controls: Control operational mode.

2. Damper Position: Indicate position of outdoor-air dampers in terms of percentage of outdoor air.

3. Status Lights:
   a. Filter dirty.
   b. Fan operating.
   c. Cooling operating.
   d. Heating operating.
   e. Smoke alarm.
   f. General alarm.

4. Digital Numeric Display:
   a. Outdoor airflow.
   b. Supply airflow.
   c. Outdoor dry-bulb temperature.
   d. Outdoor dew point temperature.
   e. Space temperature.
   f. Supply temperature.
   g. Space relative humidity.
   h. Space carbon dioxide level.

E. Control Dampers:

1. Damper Location: Factory installed inside unit for ease of blade axle and bushing service. Arrange dampers located in a mixing box to achieve convergent airflow to minimize stratification.

2. Damper Leakage: Comply with requirements in AMCA 500-D. Leakage shall not exceed 6.5 cfm per sq. ft. at a static-pressure differential of 4.0 inches water column when a torque of 5 inch pounds per sq. ft. is applied to the damper jackshaft.

3. Damper Rating: Rated for close-off pressure equal to the fan shutoff pressure.

4. Damper Label: Bear the AMCA seal for both air leakage and performance.

5. Blade Configuration: Unless otherwise indicated, use parallel blade configuration for two-position control and equipment isolation service and use modulating control when mixing two airstreams. For other applications, use an opposed-blade configuration.

6. Damper Frame Material: Extruded aluminum.

7. Blade Type: Single-thickness metal reinforced with multiple V-grooves.

8. Blade Material: Extruded aluminum.

9. Maximum Blade Width: 6 inches.

10. Maximum Blade Length: 48 inches.

11. Blade Seals: Replaceable, continuous perimeter vinyl seals and jambs with stainless-steel compression-type seals.

12. Bearings: Thrust bearings for vertical blade axles.

13. Airflow Measurement:
    a. Monitoring System: Complete and functioning system of airflow monitoring as an integral part of the damper assembly where indicated.
    b. Remote Monitoring Signal: 0-10 volt or 4-20 mA scaled signal.
    c. Accuracy of flow measurement: Within **5** percent of the actual flow rate between the range of the scheduled minimum and maximum airflow. For units with a large range between minimum and maximum airflow, configure the damper sections and flow measurement assembly as necessary to comply with accuracy.
    d. Straightening Device: Integral to the flow measurement assembly if required to achieve the specified accuracy as installed.
    e. flow measuring device: Suitable for operation in untreated and unfiltered outdoor air. If necessary, include temperature and altitude compensation and correction to maintain the accuracy.

F. Damper Operators:

1. Factory-installed electric operator for each damper assembly with one operator for each damper assembly mounted to the damper frame.

2. Operator capable of shutoff against fan pressure and able to operate the damper with sufficient reserve power to achieve smooth modulating action and proper speed of response at the velocity and pressure conditions to which the damper is subjected.

3. Maximum Operating Time: Open or close damper 90 degrees in **60** seconds.

4. Adjustable Stops: For both maximum and minimum positions.

5. Position Indicator and Graduated Scale: Factory installed on each actuator with words "OPEN" and "CLOSED," or similar identification, at travel limits.

6. Spring-return operator to fail-safe; either closed or open as required by application.

7. Operator Type: Direct coupled, designed for minimum 60,000 full-stroke cycles at rated torque.

8. Position feedback Signal: For remote monitoring of damper position.

9. Coupling: V-bolt and V-shaped, toothed cradle.

10. Circuitry: Electronic overload or digital rotation-sensing circuitry.

G. Refrigeration System Controls:

1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 26 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F.

2. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than 60 deg F.

3. Relative-humidity sensor energizes dehumidifier operation when relative humidity is more than 50 percent.

H. Electric-Resistance Heat Controls:

1. Factory-mounted sensor in unit discharge with sensor adjustment located in control panel to control electric coil to maintain temperature.
2. Wall-mounted, space-temperature sensor with temperature adjustment to control electric coil to maintain temperature.
3. Capacity Controls: Multiple steps.

I. Damper Controls: Space pressure sensor modulates outdoor- and return-air dampers to maintain a positive pressure in space at a minimum of 0.05 inch wg with respect to outdoor reference.

J. Integral Smoke Alarm: Smoke detector installed in supply and return air.

K. DDC Temperature Control: Standalone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with control system specified in Section 230900 "Instrumentation and Control for HVAC." Links shall include the following:

1. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.

2. Hardware interface or additional sensors for the following:
   a. Room temperature.
   b. Discharge-air temperature.
   c. Refrigeration system operating.
   d. Furnace operating.
   e. Constant and variable motor loads.
   f. Variable-frequency-controller operation.
   g. Cooling load.
   h. Economizer cycles.
   i. Air-distribution static pressure and ventilation-air volumes.

L. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display unit status and alarms.

1. ASHRAE 135 (BACnet) communication interface with the BAS shall enable the BAS operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the BAS.

2.11 ACCESSORIES

A. Service Lights and Switch: Factory installed in fan section with weatherproof cover. Factory wire lights to a single-point field connection.

B. Duplex Receptacle: Factory mounted in unit supply-fan section, with 20 amp 120 V GFI duplex receptacle and weatherproof cover.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 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 piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.

B. Curb Support: Install roof curb on roof structure according to "The NRCA Roofing Manual."

1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.

2. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

3. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.

C. Restrained Curb Support: Install restrained vibration isolation roof-curb rails on roof structure according to "The NRCA Roofing Manual."

1. Restrained isolation roof-curb rails are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

2. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.

3. Install flexible duct connectors. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.

4. Install vibration isolation and seismic-control devices. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation and seismic-control devices.

5. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

6. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.

D. Comply with requirements for gas-fired furnace installation in NFPA 54, "National Fuel Gas Code."

E. Install separate devices furnished by manufacturer and not factory installed.

F. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

G. Install drain pipes from unit drain pans to sanitary drain.

1. Drain Piping: Drawn-temper copper water tubing complying with ASTM B 88, Type L, with soldered joints.

2. Drain Piping: Schedule 40 PVC pipe complying with ASTM D 1785, with solvent-welded fittings.
   a. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   c. Solvent cement and adhesive primer 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."

3. Pipe Size: Same size as condensate drain pan connection.

3.4 CONNECTIONS

A. Where installing piping adjacent to units, allow space for service and maintenance.

B. Ground Loop Heat Pump Piping Connections:

1. Comply with requirements in Section 232113.33 "Ground-Loop Heat-Pump Piping."

2. Install shutoff valve and union or flange on each supply connection and install balancing valve and union or flange on each return connection.

C. Duct Connections:

1. Comply with requirements in Section 233113 "Metal Ducts."

2. Drawings indicate the general arrangement of ducts.

3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."

D. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.

1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.5 STARTUP SERVICE

A. Engage a manufacturer factory service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Inspect units for visible damage to furnace combustion chamber.

3. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
   a. High-limit heat exchanger.
   b. Alarms.

4. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.

5. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
   a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
   b. Cooling coil entering-air, dry- and wet-bulb temperatures.
   c. Condenser coil entering-air dry-bulb temperature.
   d. Condenser coil leaving-air dry-bulb temperature.

6. Simulate maximum cooling demand and inspect the following:
   a. Compressor refrigerant suction and hot-gas pressures.
   b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.

7. Inspect casing insulation for integrity, moisture content, and adhesion.

8. Verify that clearances have been provided for servicing.

9. Verify that controls are connected and operable.

10. Verify that filters are installed.

11. Clean coils and inspect for construction debris.

12. Clean furnace flue and inspect for construction debris.

13. Inspect operation of power vents.

14. Purge gas line.

15. Inspect and adjust vibration isolators and seismic restraints.

16. Verify bearing lubrication.

17. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.

18. Adjust fan belts to proper alignment and tension.

19. Start unit.

20. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.

21. Operate unit for run-in period.

22. Calibrate controls.

23. Adjust and inspect high-temperature limits.

24. Inspect outdoor-air dampers for proper stroke.

25. Verify operational sequence of controls.

26. Measure and record the following airflows. Plot fan volumes on fan curve.
   a. Supply-air volume.
   b. Return-air flow.
   c. Outdoor-air flow.

B. After startup, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.

D. Prepare written report of the results of startup services.

3.6 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. Engage a manufacturer factory service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 74 33

SECTION 23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS

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 split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. LEED Submittals:

1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set for each air-handling unit.

2. Gaskets: One set for each access door.

3. Fan Belts: One set for each air-handling unit fan.

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. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:
   a. For Compressor: Five year(s) from date of Substantial Completion.
   b. For Parts: Five year(s) from date of Substantial Completion.
   c. For Labor: Five year(s) 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. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.

2. Trane; a business of American Standard companies.

3. YORK; a Johnson Controls company.

4. Liebert

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.

2. Insulation: Faced, glass-fiber duct liner.

3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.

4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.

5. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

6. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

7. Fan Motors:
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
   c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

9. Filters: Permanent, cleanable.

10. Condensate Drain Pans:
    a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
       1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
       2) Depth: A minimum of 2 inches deep.
    b. Double-wall, galvanized-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
    c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
       1) Minimum Connection Size: NPS 1.
    d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
    e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
    f. Provide switch to automatically shut unit down upon rise in condensate and signal BMS.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. 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.

2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   a. Compressor Type: Scroll.
   b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
   c. Refrigerant Charge: R-407C.
   d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.

4. Fan: Aluminum-propeller type, directly connected to motor.

5. Motor: Permanently lubricated, with integral thermal-overload protection.

6. Low Ambient Kit: Permits operation down to 45 deg F.

7. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC."

B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

C. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.

2. 24-hour time control of system stop and start.

3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.

4. Fan-speed selection including auto setting.

D. Automatic-reset timer to prevent rapid cycling of compressor.

E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

F. Drain Hose: For condensate.

G. Additional Monitoring:

1. Monitor constant and variable motor loads.

2. Monitor variable-frequency-drive operation.

3. Monitor economizer cycle.

4. Monitor cooling load.

5. Monitor air distribution static pressure and ventilation air volumes.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground-mounted, compressor-condenser components on 4-inch- thick, reinforced concrete base that is 4 inches larger, on each side, than unit. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

D. Install ground-mounted, compressor-condenser components on polyethylene mounting base.

E. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

F. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. See Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

G. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.3 CONNECTIONS

A. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

B. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a manufacturer factory service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a manufacturer factory service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a manufacturer factory service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 DEMONSTRATION

A. Engage a manufacturer factory service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26

SECTION 238146 - WATER-SOURCE UNITARY HEAT 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 types of water-source heat pumps:

1. Concealed horizontal or vertical units, 5 tons and smaller.
2. Rooftop

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each model.

B. LEED Submittals:

1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

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. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, 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. Suspended ceiling components.
2. Structural members to which heat pumps will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.

5. Items penetrating finished ceiling, including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.

B. Product Certificates: For each type of water-source heat pump, signed by product manufacturer.

C. Field quality-control test reports.

D. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water-source heat pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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. One set(s) of matched fan belts for each belt-driven fan.
2. One set(s) of filters for each unit.

1.7 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of water-source heat pumps and are based on the specific system indicated. Refer to Section 016000 "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.

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. ASHRAE Compliance:

1. ASHRAE 15.
2. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Comply with NFPA 70.

F. Comply with safety requirements in UL 484 for assembly of free-delivery water-source heat pumps.

G. Comply with safety requirements in UL 1995 for duct-system connections.

1.8 COORDINATION

A. Coordinate layout and installation of water-source heat pumps and suspension components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components, and partition assemblies.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water-source heat pumps that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, refrigeration components.
2. Warranty Period: Five years from date of Substantial Completion.

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 CONCEALED WATER-SOURCE HEAT PUMPS, 5 TONS AND SMALLER

A. Manufacturers:
1. Trane.
2. Carrier Corporation.
3. ClimateMaster, Inc.
4. FHP Manufacturing Inc.
5. McQuay International.

B. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ARI-ISO-13256-1.

C. Cabinet and Chassis: Galvanized-steel casing with the following features:

1. Access panel for access and maintenance of internal components.
2. Knockouts for electrical and piping connections.
3. Flanged duct connections.
4. Cabinet Insulation: Glass-fiber liner, minimum 1/2 inch thick, complying with UL 181.
5. Condensate Drainage: Plastic or stainless-steel drain pan with condensate drain piping projecting through unit cabinet and complying with ASHRAE 62.1.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Sound Attenuation Package:

    a. Minimum 0.598-inch- thick compressor enclosure and front panel. Minimum 0.0937-inch- thick foam gasket around the compressor and perimeter of end panel.
    b. Sound attenuating blanket over compressor.
    c. Hot-gas muffler.

D. Fan: Direct driven, centrifugal, with variable speed motor resiliently mounted in fan inlet.

1. General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Motor: Multispeed, permanently lubricated, ECM motor.

E. Water Circuit:

1. Refrigerant-to-Water Heat Exchangers:

    a. Coaxial heat exchangers with copper water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube leak tested to 450 psig on refrigerant side and 400 psig on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
2. Water Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger, and control head pressure on compressor during cooling and heating. Valves shall close when heat-pump compressor is not running.
3. Motorized Water Valve: Stop water flow through the unit when compressor is off.

F. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to 450 psig.

G. Refrigerant Circuit Components:

1. Sealed Refrigerant Circuit: Charge with R-410A refrigerant.
2. Filter-Dryer: Factory installed to clean and dehydrate the refrigerant circuit.
3. Charging Connections: Service fittings on suction and liquid for charging and testing.
4. Reversing Valve: Pilot-operated sliding-type valve designed to be fail-safe in heating position with replaceable magnetic coil.
5. Compressor: Hermetic rotary and scroll compressor installed on vibration isolators and housed in an acoustically treated enclosure with factory-installed safeties as follows:

    a. Antirecycle timer.
    b. High-pressure cutout.
    c. Low-pressure cutout or loss of charge switch.

d. Internal thermal-overload protection.
e. Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below 35 deg F.
f. Condensate overflow switch to stop compressor with high condensate level in condensate drain pan.

6. Refrigerant Piping Materials: ASTM B 743 copper tube with wrought-copper fittings and brazed joints.
7. Pipe Insulation: Refrigerant minimum 3/8-inch- thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-development indexes according to ASTM E 84.
8. Refrigerant Metering Device: Capillary tube.
9. Refrigerant Metering Device: Thermal expansion valve to allow specified operation with entering-water temperatures from 25 to 125 deg F.
10. Hot-Gas Reheat Valve: Pilot-operated sliding-type valve with replaceable magnetic coil.

H. Hot-Gas Reheat: Reheat valve diverts refrigerant hot gas to reheat coil when remote humidistat calls for dehumidification.

I. Filters: Disposable, glass-fiber, flat type, 2 inch thick, treated with adhesive, and having a minimum efficiency reporting value of 13 according to ASHRAE 52.2.

J. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence and Operations for HVAC Controls."

K. Controls:

1. Basic Unit Controls:

a. Low- and high-voltage protection.
b. Overcurrent protection for compressor and fan motor.
c. Random time delay, three to ten seconds, start on power up.
d. Time delay override for servicing.
e. Control voltage transformer.

2. Thermostat:

a. Wall-Mounted Thermostat:

1) Heat-cool-off switch.
2) Fan on-auto switch.
3) Automatic changeover.
4) Concealed temperature set point.
5) Concealed temperature indication.
6) Deg F indication.

b. Wall-mounted temperature sensor.
c. Unoccupied period override push button.
d. LED to indicate fault condition at heat pump.

e. Data entry and access port.

1) Input data include room temperature and humidity set points for occupied and unoccupied periods.
2) Output data include room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

3. Terminal Controller:

a. Scheduled operation for occupied and unoccupied periods on 7-day clock with minimum 4 programmable periods per day.
b. Two-hour unoccupied period override period.
c. Remote control panel to contain programmable timer and LED for fault condition.
d. Compressor disable relay to stop compressor operation for demand limiting or switch to unoccupied operation.
e. Automatic restart after five minutes if fault clears. Lockout after three attempts to restart following fault. Indicate fault for service technician.
f. Return-air temperature high-limit (firestat). Stop unit on high temperature.
g. Backup for volatile memory.
h. Differential pressure switch to indicate fan status. Fan failure alarm.
i. Differential pressure switch to indicate filter status. Dirty filter alarm.

4. BAS interface requirements as further described in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence and Operations for HVAC Controls."

a. Interface relay for scheduled operation.
b. Interface relay to provide indication of fault at central workstation.
c. Provide BAC-net interface for central BAS workstation for the following functions:

1) Set-point adjustment for set points identified in this Section.
2) Start/stop and operating status of heat-pump unit.
3) Data inquiry to include supply air, room air temperature and humidity, and entering-water temperature.
4) Occupied and unoccupied schedules.

L. Provide optional deluxe sound attenuation package in order to achieve 40dBA sound levels inside classrooms and core learning area.

M. Electrical Connection: Single electrical connection with fused disconnect.

2.3 HOSE KITS

A. General: Hose kits shall be designed for minimum 400 psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.

B. Hose: Length 24 inches. Minimum diameter, equal to water-source heat-pump connection size.

C. Isolation Valves: Two-piece bronze-body ball valves with stainless-steel ball and stem and galvanized-steel lever handle. Provide valve for supply and return. If balancing device is combination shutoff type with memory stop, the isolation valve may be omitted on the return.

D. Strainer: Y-type with blowdown valve in supply connection.

E. Balancing Device: Mount in return connection. Include meter ports to allow flow measurement with differential pressure gage.

1. Automatic balancing valve, factory set to operate within 10 percent of design flow rate over a 40:1 differential pressure range of 2 to 80 psig.
2. Manual, calibrated-orifice balancing valve.
3. Manual, venturi-type balancing valve.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of water-source heat pumps.

B. Examine roughing-in for piping and electric installations for water-source heat pumps to verify actual locations of piping connections and electrical conduit before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting: Install water-source heat pumps with continuous-thread hanger rods and spring hangers of size required to support weight of water-source heat pump unit.

1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install wall-mounting thermostats, humidistats, and switch controls in electrical outlet boxes at heights to match lighting controls or as required in Section 230900 "Instrumentation and Control for HVAC."

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Connect supply and return hydronic piping to heat pump with hose kits.

2. Connect heat-pump condensate drain pan to indirect waste connection with condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

B. Duct installation requirements are specified in other Sections. Drawings indicate general arrangement of ducts. Specific connection requirements are as follows:

1. Connect supply and return ducts to water-source heat pumps with flexible duct connectors specified in Section 233300 "Air Duct Accessories."

C. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

D. Install piping adjacent to machine to allow service and maintenance.

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."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. After installing water-source heat pumps and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a manufacturer factory service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to compressor, coils, and fans.
3. Inspect internal insulation.
4. Verify that labels are clearly visible.

5. Verify that clearances have been provided for servicing.
6. Verify that controls are connected and operable.
7. Verify that filters are installed.
8. Adjust vibration isolators.
9. Inspect operation of barometric dampers.
10. Verify bearing lubrication on fan.
11. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
12. Adjust fan belts to proper alignment and tension.
13. Start unit according to manufacturer's written instructions.
14. Complete startup sheets and attach copy with Contractor's startup report.
15. Inspect and record performance of interlocks and protective devices; verify sequences.
16. Operate unit for an initial period as recommended or required by manufacturer.
17. Verify thermostat and humidistat calibration.
18. Inspect controls for correct sequencing of heating, refrigeration, and normal and emergency shutdown.
19. Start refrigeration system and measure and record the following:

    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.

20. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Return-air volume.

3.6 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.7 CLEANING

A. Replace filters used during construction prior to air balance or substantial completion.

B. After completing installation of exposed, factory-finished water-source heat pumps, inspect exposed finishes and repair damaged finishes.

3.8 DEMONSTRATION

A. Engage a manufacturer factory service representative to train Owner's maintenance personnel to adjust, operate, and maintain water-source heat pumps. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 81 46

SECTION 23 82 33 - CONVECTORS

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. This Section includes the following:

1. Electric baseboard radiators.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For convection heating units 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 ELECTRIC BASEBOARD RADIATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Airtherm.
2. American Air Filter.
3. McQuay.
4. Rittling.
5. Sterling.
6. Trane.
7. Vulcan.
8. Qmark

B. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.

C. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded to fins, with high-temperature cutout and sensor running the full length of the element. Element supports shall eliminate thermal expansion noise.

D. Rust-Resistant Enclosures: Minimum 0.052-inch- thick ASTM A 653/A 653M, G60 galvanized-steel, removable front cover.

1. Full-height back.
2. Full-length damper.
3. End panel.
4. End caps.
5. Inside and outside corners.
6. Joiner pieces to snap together.
7. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.
8. Element Brackets: Primed and painted steel to support front panel and element.

E. Unit Controls: Integral line-voltage thermostat.

F. Accessories:

1. Filler sections without a heating element matching the adjacent enclosure.
2. Straight-blade-type receptacles complying with DSCC W-C-596G/GEN, NEMA WD 1, NEMA WD 6, and UL 498; in color selected by Architect.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Examine areas to receive convection heating units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for electrical connections to verify actual locations before convection heating unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 BASEBOARD RADIATOR INSTALLATION

A. Install units level and plumb.

B. Install enclosure continuously around corners, using outside and inside corner fittings.

C. Join sections with splice plates and filler pieces to provide continuous enclosure.

D. Install access doors for access to valves.

E. Install enclosure continuously from wall to wall.

F. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

G. Install air-seal gasket between wall and recessing flanges or front cover of fully recessed unit.

3.4 CONNECTIONS

A. Install control valves as required by Section 230900 "Instrumentation and Control for HVAC."

B. Ground electric convection heating units according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 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 convection heating unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace convection heating units that do not pass tests and inspections and retest as specified above.

END OF SECTION 23 82 33

SECTION 23 82 39 - 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. This Section includes the following:

1. Propeller unit heaters with electric coils.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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.

1.7 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

PART 2 - PRODUCTS

2.1 PROPELLER UNIT HEATERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Airtherm; a Mestek Company.
2. American Air Filter.
3. McQuay International.
4. Rittling.
5. Sterling.
6. Trane.
7. Vulcan.
8. Qmark

B. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

C. Comply with UL 2021.

D. Comply with UL 823.

E. Cabinet: Removable panels for maintenance access to controls.

F. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

G. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

H. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

I. General Coil Requirements: Test and rate hot-water propeller unit heater coils according to ASHRAE 33.

A. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.

1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

B. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

C. Fan Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Type: Permanently lubricated, variable speed.

D. Control Devices:

1. Unit-mounted, variable fan-speed switch.

2. Unit-mounted thermostat.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 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.

3.3 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Install propeller unit heaters level and plumb.

D. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

F. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

G. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.4 CONNECTIONS

A. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Section 233300 "Air Duct Accessories."

B. Comply with safety requirements in UL 1995.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 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. Report results in writing.

B. 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.

2. Operate electric heating elements through each stage to verify proper operation and electrical connections.

3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

A. Adjust initial temperature set points.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 82 39

SECTION 26 05 00 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK

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. Every Section of Division 26 described herein is binding upon each Contractor involved insofar as it can or does apply to him or his work.

B. This Contractor shall furnish, install and connect an operating electrical installation in accordance with these specifications and accompanying Contract Drawings. This shall include all required labor, materials, apparatus and supervision.

C. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 DEFINITIONS

A. Contractor: “Contractor”, “this Contractor” or “Electrical Contractor” when used in this specification refers to the Contractor responsible for all work under this Section.

B. Sub Contractor: Any references to, or letting of work contained in these specifications to any Sub Contractor or manufacturer does not relieve this Contractor of his responsibility for all work, material and equipment in this specification.

C. Provide: The term “Provide” when used separately shall mean to “Furnish and Install”.

D. Furnish: The term “Furnish” when used separately shall mean to obtain and deliver to the project site for installation by others.

E. Install: The term “Install” when used separately shall mean to mount in place, connect and make operable.

F. Gauge of Materials: The sizes of copper conductors and thickness of metals shown on the drawings or mentioned herein shall be understood to be American Wire Gauge for conductors and US Gauge for sheet metal.

G. Singular Number: Any reference made to an item in the singular number shall apply equally to as many identical items that work may require.

1.4 REGULATIONS AND CODES

A. All applicable laws, ordinances, rules and regulations of public bodies bearing on the conduct of the work, including but not limited to, the State Department of Health, Department of Labor and Industry, the National Fire Protection Association, the Americans with Disabilities Act and the Owner's insuring agency are hereby incorporated and made a part of these specifications.

B. Should any change in the drawings and/or specifications be required to conform to the codes, ordinances, regulations or laws mentioned above, the Architect shall be notified prior to the time of submitting bids. After signing the Contract, each Contractor will be responsible for the completion of all work necessary to meet the above-mentioned requirements without additional expense to the Owner.

C. The Contractor shall comply with all rules, regulations and recommendations of any public utility serving this project.

D. The entire electrical system shall be installed in accordance with the 2011 National Electric Code, approved by the governmental body having jurisdiction, including amendments thereto.

1.5 DRAWINGS AND SPECIFICATIONS

A. The drawings are generally diagrammatic and indicative of the work to be installed. Exact locations of equipment and points of termination shall be approved by the Architect. Should it be found that any system or equipment cannot be installed as shown on the drawings, the Architect shall be consulted before installing or making changes to the layout.

B. The drawings and specifications are intended to function as a common set of documents. Anything shown on the drawings but not in the specifications, or mentioned in the specifications and not shown on drawings, shall be equally binding as if both noted on the drawings and called for in the specifications.

C. No measurement of a drawing by scale shall be used as a working dimension. Working measurements shall be taken from figured dimensions and through cooperation with all other Contractors.

D. This Contractor shall carefully examine the Architectural, Structural, Heating, Ventilating, Air Conditioning, Plumbing and miscellaneous Contract Drawings and Specifications. If any discrepancies occur between the drawings or between the drawings and specifications, he shall report such discrepancies to the Architect in writing and obtain written instructions as to the manner in which to proceed. No departures from the Contract Drawings shall be made without prior written approval of the Architect.

1.6 FAMILIARITY WITH CONTRACT REQUIREMENTS

A. It is the responsibility of the Contractor, prior to submitting his bid on this Project, to satisfy himself as to the nature and location of the work, the conformation of the ground, soil characteristics, the character, quality and quantity of the materials which will be required, the character equipment and facilities needed preliminary to and during the prosecution of the work, the general and local conditions and of all other matters which can in any way affect the work under this Contract.

B. Failure to make onsite inspection prior to submitting a bid, or failure to comply with any or all of the above requirements will not relieve this Contractor from the responsibilities of properly estimating the requirements or costs of successful completion of the work nor from the responsibility for the faithful performance of the provisions of this Contract.

1.7 STANDARDS AND REFERENCES

A. Products of workmanship that are specified by association, trade or federal standards shall comply with the requirements of the following reference standards except when more rigid requirements are specified or are required by applicable codes.

1. ANSI - American National Standard Institute.

2. ASTM - American Society for Testing and Materials.

3. FM - Factory Mutual System.

4. FS - Federal Specification.

5. IEEE - Institute of Electrical and Electronics Engineers.

6. MIL - Military Specification.

7. NEMA - National Electrical Manufacturers Association.

8. NFPA - National Fire Protection Association.

9. UL - Underwriters Laboratories, Inc.

1.8 SUBMITTALS

A. Approval of Materials

1. Within 10 days after signing the Contract, the Contractor shall submit to the Architect for approval, a complete list of materials, equipment and Sub Contractors proposed for use on this Project.

2. List shall include, in itemized form, the name and address of the Manufacturer, equipment or Sub Contractor and when required, the trade name or catalog number of the proposed material.

3. Submit electronically through Proliance system.

B. Shop Drawings:

1. The Contractor shall submit to the Architect shop drawings, catalog cuts, data sheets, manufacturer's instructions, etc. of all materials and equipment as called for herein and/or as called for in the individual sections of Division 26 under submittals.

2. Shop drawings submitted for review shall identify the Project. Contractor, Sub Contractor or Supplier, pertinent drawing number, detail and specification section number as appropriate.

3. Shop drawings shall bear the Contractor's approval stamp, signed or initialed certifying that review, verification of the material required, dimensions and coordination of the information is in accordance with the requirements of the work and Contract Documents. Drawings submitted without the Contractor's approval stamp will not be considered and will be returned for resubmission.

4. No work shall be executed, no orders placed, no material shall be installed until final review has been received.

5. Submit electronically through Proliance system.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

D. Electrical Inspection Certificate:

1. The electrical work on this Project shall be inspected by an approved inspection agency. All inspection costs shall be paid by the Electrical Contractor. Any work failing to pass inspection shall be corrected and re-inspected at no additional cost to the Owner. The Electrical Contractor shall formally file for this inspection within 20 days of signing the Contract.

2. Submit electronically through Proliance system.

3. Approved Inspection Agencies:
   a. Atlantic Inland, Inc.
   b. Middle Atlantic Inspections, Inc.
   c. Middle Department Inspection Agency.

E. Testing:

1. Upon completion of the work, all parts of the electrical installation shall be tested by this Contractor and proved free of unwanted grounds and other defects. Preliminary testing shall with magneto will be permitted but will not be accepted in obtaining final results. Final tests shall be accomplished by use of a megger or as covered in this specification. The values of all secondary materials and equipment insulation shall meet or exceed the aforementioned regulatory bodies.

2. All connections at panels and switches and all splices must be made, all fuses shall be in place and all circuits continuous from point of service connections to switches, receptacles and outlets at the time of final inspection.

3. All overload devices, including equipment furnished under other contracts shall be set and adjusted to suit the load conditions.

4. Submit electronically through Proliance system.

F. Operation and Maintenance Manuals:

1. This Contractor shall carefully compile, during process of work, all operation and maintenance manuals. The manual shall include, at a minimum:
   a. Table of contents for each volume.
   b. Contact Information for all contractors, sub-contractors, and all service firms for each item.
      1) Include names, addresses and phone numbers of all Sub Contractors and of service firms for each item, for Owner's use after expiration of the guarantee period. The list shall be located immediately inside the front cover.
   c. All approved electrical shop drawings.
   d. All electrical equipment manuals, which will encompassed the following information:
      1) Parts list for each component including recommended spare parts list.
      2) Methods of care of all types of materials and descriptions of all systems and equipment and methods of operation thereof shall be provided. Descriptions shall give pertinent diagrams, identifying charts, color-coding, connections, lubricating instructions and single-line and detailed wiring diagrams. These instructions shall contain detailed operating and maintenance instructions and complete parts lists for each piece of equipment and diagrams of control wiring so arranged that the maintenance staff may easily trace the control in case of operating difficulties. Use Manufacturer's printed information where possible; otherwise, obtain written instructions prepared by Sub Contractors.
   e. Copies of all certificates and warranties.
   f. Copies of all test reports.
   g. Full size copies of required project drawings, including, but not limited to:
      1) Occupancy sensor layout and diagrams, if applicable.
      2) Lighting control system layout and diagrams, if applicable.
      3) Other process control diagrams as specified herein, if applicable.
   h. One complete set of instructional DVDs, recorded during instructional presentations by electrical contractor as specific herein, and in all related Division 26 sections.

2. Before completion of the work, submit a rough draft of the manual in a loose-leaf binder for approval.

3. After approval and before final payment, furnish the following media:
   a. Two corrected bound copies, properly identified, to Architect for transmittal to the Owner.
   b. One PDF electronic copy on DVD optical disc storage media.

G. Guarantee:

1. Written 1 year full warranty guarantees shall be submitted for the entire electrical installation installed under this Project (except lamps). The emergency lighting system shall carry a full warranty guarantee for 3 years. Where Manufacturer's standard guarantee provides for a longer period, the longer period shall apply.

2. Where defects in the material, equipment and/or workmanship become evident within this guarantee period, the Contractor shall be responsible for replacing such material and equipment with the approved type of new items; and/or correcting the defective workmanship without any costs to the Owner.

H. Construction Record Drawings:

1. The Contractor shall keep at the job site 1 complete set of drawings which shall be used by the Contractor for the purpose of recording all changes that occur during the construction. The Contractor shall accurately record on these drawings all changes in the electrical work.

2. Upon completion of this Project, these drawings shall be turned over to the Architect.

I. Final Wiring Certificates:

1. Submit 3 copies of final wiring certificates to the Architect.

1.9 SUBSTITUTIONS AND SAMPLES

A. All material specified hereinafter shall be of the Manufacturer's catalog number as specified. If the Contractor desires to substitute, Contractor must submit catalog cuts of the substituted materials to the Architect 10 calendar days in advance of the bid date to allow ample time for consideration. A decision will be rendered and an addendum will be issued to all Contractors listing any "acceptable substitutes".

B. No substitutions shall be made without approval. The words "approved equal" and "equal" shall mean equal in all respects in the opinion of the Professional.

C. The Electrical Contractor shall furnish, for review by the Professional, all samples specified or called for by the Architect. Finished work shall match approved samples and shop drawings.

D. When shop drawings are submitted on equipment different from the equipment specified hereinafter, this Contractor shall relate each item of the submitted equipment to its specified equivalent.

E. All costs involved in charges in the building, to the equipment, to the arrangement of equipment, or to the work performed or to be performed under other sections of the specifications, due to the substitution of equipment in lieu of that shown on the drawings or specified, shall be borne by this Contractor making such substitutions and shall include but not necessarily be limited to, costs or fees in connection with resubmission of drawings for approval, if required, by the State of Maryland, the City of Baltimore, local authorities or insuring agencies or insuring agencies having jurisdiction over the work.

1.10 QUALITY OF WORKMANSHIP

A. All work shall be installed in a first class, neat and workmanship shall be subject to the approval of the Professional. Any work found by the Professional to be of inferior quality and/or workmanship shall be replaced and/or reworked until approval of the Professional is obtained. Any cost involved in obtaining said approval shall be the responsibility of the Electrical Contractor.

1.11 PERFORMANCE OF EQUIPMENT

A. All materials, equipment and appurtenances of any kind, shown on the drawings, hereinafter specified or required for the completion of the work in accordance with the intent of these specifications, shall be completely satisfactory and acceptable in operation, performance and capacity. No approval, either written or verbal, of any drawings, descriptive data of samples of such material, equipment and/or appurtenances, shall relieve the Electrical Contractor of his responsibility to turn over the same to the Owner in perfect working order at the completion of the work.

B. Any material, equipment or appurtenances, the operation capacity performance of which does not comply with the drawings and/or specification requirements, or which is not new, or which is damaged prior to acceptance by the Owner, will be held to be defective material and shall be removed and replaced with proper acceptable materials, equipment and/or appurtenance or put in proper acceptable working order, satisfactory to the Architect without additional cost to the Owner.

C. All auxiliary systems provided under this specification, including the emergency lighting system, fire alarm system, sound system, clock system, television system or other similar systems shall be furnished by Manufacturers who have been regularly engaged in the manufacture of these products for a period of not less than 5 years. This Contractor shall deliver to the Architect prior to final payment, a statement from the Manufacturer or his authorized representative, certifying that the equipment has been inspected by him and found to be properly installed and functioning satisfactorily. Installation, final connections and testing of such systems shall be made under the direct supervision of competent authorized service engineers who shall be in the employ of the respective equipment Manufacturer. Any and all expenses incurred by these equipment Manufacturer’s representatives shall be borne by the Electrical Contractor.

D. All details of the installation of all equipment shall be electrically and mechanically correct. All equipment shall operate without objectionable noise or vibration as determined by the Architect and Owner. If objectionable noise or vibration is produced and transmitted to occupied portions of the building by apparatus, conduit or other parts of a system, any corrections to eliminate noise and vibration shall be made without cost to the Owner.

1.12 TEMPORARY FACILITIES

A. Electrical Contractor shall furnish, install, connect and maintain temporary electrical services to the building until new, permanent services are installed. Complete installation and maintenance of temporary services shall meet all NEC and OSHA requirements.

1.13 METHODS AND MATERIALS

A. The Electrical Contractor shall confer with all other Contractors and shall apply for detailed and specific information regarding the location of all equipment as the final location may differ from that indicated on the drawings. Outlets, equipment or wiring improperly placed because of the Electrical Contractor's failure to obtain this information shall be relocated and reinstalled by the Electrical Contractor without additional expenses to the Owner.

B. Each Contractor, upon request of the Architect shall expedite the work of a specific area, section or part of the project to make provision for, or protect equipment or to permit the installation of another part of the work.

C. All materials and equipment supplied by this Contractor shall be new, of the best of their respective kinds, without imperfections and blemishes and shall be protected from the elements prior to installation in the building.

D. All conduits, wire, cable, wiring devices and equipment shall be installed in such a manner as to preserve access to any existing equipment or to any new equipment installed under this specification or under other specifications or contracts for this building and with sufficient space provided for proper operation and maintenance.

E. The drawings are generally indicative of the work to be installed but do not indicate all bends, fittings, boxes, etc., which may be required. Contractor shall carefully investigate the structure and finish conditions affecting his work, arrange his work accordingly and furnish such fittings as may be required to meet such conditions.

F. This Contractor shall coordinate his work with that of other trades so that all work may be installed in the most direct manner and so that no interference or fouling results, the Architect shall decide which work is to be relocated, regardless of which is first installed. Such relocation shall be at no additional cost to the Owner.

G. All materials and equipment installed by the Contractor shall be firmly supported and secured to the building construction where required.

H. All items of labor, material and equipment not specified in detail or shown on the drawings but incidental to or necessary for the complete and proper installation and proper operation of the several branches of the work described herein or reasonably implied in connection therewith, shall be furnished as if called for in detail by the specifications or drawings.

I. Major items of equipment shall be the best grade and quality used for the purpose in commercial practice and shall have the Manufacturer's name, address and catalog number on a plate securely affixed in a prominent place. All electrical equipment or apparatus of any 1 system must be the product of 1 Manufacturer, or equivalent products of a number of Manufacturers, which are suitable for use in a unified system.

J. When available, all materials and equipment shall bear the label of approval of the Underwriters' Laboratory, Inc.

1.14 SLEEVES

A. The Electrical Contractor shall provide sleeves where required to protect equipment or facilities in the installation. Each sleeve shall extend through its respective floor, wall or partition and shall be cut flush with each surface unless otherwise required.

B. Sleeves in bearing and masonry walls, floors and partitions shall be of standard weight steel pipe finished with smooth edges. For other masonry partitions through suspended ceilings and for concealed vertical piping, sleeves shall be Number 22 U.S.G. galvanized iron.

C. All sleeves shall be properly installed and securely cemented in place.

D. Floor sleeves shall extend 1 inch above the finished floor. Space between floor sleeves and passing conduit shall be caulked with graphite packing and waterproof caulking compound as required for a waterproof installation.

E. Where conduits pass through waterproofed floors or walls, design of sleeves shall be such that waterproofing can be flashed into and around the sleeves.

F. Sleeves through exterior walls below grade shall have the spaces between conduit and sleeve caulked watertight.

1.15 CHASES AND OPENINGS

A. All openings or chases required for the installation of the electrical work in the building shall be provided by the General Contractor, providing the Electrical Contractor shall notify the General Contractor of the size and location of the required openings or chases in sufficient time before the work is closed in so that the work of the General Contractor will not be delayed.

B. If the General Contractor is not notified in sufficient time, so that a delay is caused in his work, the General Contractor will cut and patch the openings and/or chases and charge the Electrical Contractor for the work involved.

C. This Contractor shall seal all openings he has made in fire rated floors, ceilings or partitions after his work has been installed. The material used for sealing the openings shall have a fire rating equal to or greater than the fire rating of the floor, ceiling or partition material. All fire stop material shall be UL classified. Fire stop sealants, foams and compounds shall be as manufactured by Dow Corning or Nelson.

1.16 ACCESS PANELS

A. The Electrical Contractor shall provide and turn over to the General Contractor for installation by him all access panels required for work under this Electrical Contract. Access panels shall not be smaller than 24 inches by 24 inches for access to concealed pull boxes, junction boxes or similar items where no other means of access is provided.

B. Each access panel shall be all steel construction with a wall or ceiling frame and a hinged panel door. Doors shall be provided with a full piano hinges and suitable clips and countersunk screws. Access panels shall have a 1 hour fire rating and shall also be labeled. Outside of access panels shall finish flush with finished wall or ceiling surfaces and be prime painted.

1.17 SCAFFOLDING

A. The Electrical Contractor shall furnish and erect all scaffolding and ladders required in the installation of wiring, equipment and fixtures.

1.18 EQUIPMENT FOUNDATIONS

A. The provision of all concrete equipment foundations required for the equipment furnished under these electrical specifications shall be the responsibility of the Electrical Contractor. Foundations shall be of sufficient mass to suit the equipment furnished.

1.19 CLEAN-UP

A. Upon completion of the electrical work and when directed by the Architect this Contractor shall remove all dirt, foreign materials, stains, fingerprints, etc., from all lighting fixtures, panels, plates, etc., installed under this project and shall leave the electrical work in such a condition that no cleaning by the Owner is required. Internal areas of all equipment must be cleaned of all construction dust, etc., prior to pre-final and/or final inspection.

B. Periodically and at the completion of the work contemplated under these specifications, the Contractor shall remove from the building site and construction areas as rubbish and accumulated materials of whatever nature not caused by other trades and shall leave the work in a clean, orderly and acceptable condition at all times.

1.20 PROTECTION OF WORK, MATERIALS AND EQUIPMENT

A. This Contractor shall effectually protect at his own expense all existing facilities and such of his new work, materials or equipment as is liable to injury during the construction period. All openings into any part of the conduit system as well as all associated fixtures, equipment, etc., both before and after being set in place must be securely covered or otherwise protected to prevent obstruction, damage or injury due to carelessly or maliciously dropped tools or materials, grit, dirt, moisture, water or any foreign matter. This Contractor shall be held responsible for all damage so done, until his work is fully accepted by the Architect. Conduit ends shall be covered with capped bushings.

B. All surfaces either finished or in preparation for finishing or finish material application, shall be protected against damage from welding, cutting, burning, soldering or similar construction functions. The protection shall be accomplished by care in operations, covering and shielding. Special care shall be directed to exposed finish masonry, metal or wood surfaces and painted surfaces. Corrective measures required shall be accomplished by the trade which made the original installation when and as directed by the Architect at the expense of the Contractor causing the damage and at no cost to the Owner.

C. Any damage caused by neglect on the part of this Contractor or his representatives, either to the existing work or to his work or to the work of any other Contractor shall be repaired at his expense to the Architect's satisfaction.

1.21 PROTECTION OF SERVICES AND EQUIPMENT

A. The Contractor shall, at his own expense, repair, replace and maintain in service any utilities, facilities or services (underground, over ground, interior or exterior) damaged, broken or otherwise rendered inoperative during the course of construction by him or his representatives. The method used by the Contractor in repairing, replacing or maintaining the services shall be approved by the Architect.

1.22 INSTRUCTIONS

A. After all tests and adjustments have been made, the Electrical Contractor shall fully instruct the representatives of the Owner in all details of operation and maintenance of equipment installed under this Contract. Allow 2 days (8 manhours per day) for instructions. Additional instruction may be required for specialty systems as directed in other specification sections.

1. Each demonstration session shall be recorded in DVD media format (video and audio). Only persons knowledgeable in DVD optical storage media for video and audio production and editing will be employed for video documentation.

PART 2 - PRODUCTS - Not Used.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

END OF SECTION 26 05 00

SECTION 26 05 10 - ELECTRICAL DEMOLITION FOR RENOVATIONS

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. Electrical demolition.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work:

1. As specified in individual Sections.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Verify field measurements and circuiting arrangements are as shown on the drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Owner before disturbing existing installation.

D. Thoroughly survey the existing building to determine the extent and cost of removal work, relocation of existing equipment and materials, re-energizing of existing circuits and/or equipment and installing of new equipment materials in the existing building.

E. Beginning of demolition means Contractor accepts existing conditions.

3.3 PREPARATION

A. Disconnect electrical systems in walls, floors and ceilings scheduled for removal.

B. Coordinate utility service outages with Utility Company.

3.4 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and/or extend existing electrical work as indicated on Contract Drawings.

B. Disconnect and remove/relocate, and/or extend as required existing installations to accommodate new construction.

C. Disconnect and remove all wiring unless noted otherwise.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finished. Cut conduit flush with walls and floors and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.

1. Provide Type 302 Stainless Steel blank outlet covers in all locations.

F. Disconnect and remove abandoned panelboards and distribution equipment. Disconnect and remove interiors and covers from abandoned flush mounted panelboards.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers and other accessories.

I. Repair adjacent construction and finishes damaged during demolition and extension work.

J. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

K. Extend existing installations using materials and methods as specified.

L. Disconnect and remove abandoned fire alarm cable that is not terminated at equipment other than a connector and not identified for future use with a tag.

3.5 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or are to be reused.

3.6 INSTALLATION

A. All openings or chases for the installation of the electrical work in the existing portion of the building shall be the responsibility of the Electrical Contractor.

B. All openings cut into the exterior of the existing structure must be completely sealed and waterproofed before leaving the job site each day. This shall be done by the Contractor responsible for the cutting.

3.7 CUTTING, PATCHING, FINISHING AND PAINTING

A. Electrical Contractor shall be responsible for all cutting, patching and finishing for the proper installation of all electrical equipment and materials to be installed in the existing portion of this project. This will also be required for the removal of the existing equipment and materials. All cutting shall be kept to an absolute minimum consistent with the requirements of the project. Cutting, patching and finishing shall be done by workmen skilled in this type of work. All patching shall be done utilizing materials of the same quality and texture as the adjacent undisturbed areas. All finishing shall match the undisturbed adjacent areas perfectly and to the satisfaction of the Architect. Painting shall comply with the painting specifications hereinafter.

B. Cutting shall be accomplished in such a manner as not to cause damage to the building or leave unsightly surfaces which cannot be concealed by plates, escutcheons or other construction. Where such unsightly conditions are caused, the Contractor shall be required, at his own expense, to repair the damaged areas.

C. Where cutting is required in the existing construction for the work installed under this Contract, such cutting shall be done by this Contractor unless otherwise noted on the drawings or hereinafter specified. This Contractor shall do all patching, repairing and finishing provided the cutting is neatly done and limited to the minimum size required for the installation.

D. Cutting of the construction excessively or carelessly done shall be repaired by this Contractor to match the original work and to the satisfaction of the Architect who will make the final decision with respect to excessive or careless cutting work.

E. No cutting shall be done which may affect the building structurally or architecturally without first securing the approval of the Architect. Cutting shall be accomplished in such a manner as not to cause damage to the building or leave unsightly surfaces that cannot be concealed by plates, escutcheons or other construction. Where such unsightly conditions are caused, the Contractor shall be required, at his own expense, to repair the damaged areas.

F. This Contractor shall seal all openings he has made in plenum spaces, fire rated floors, ceilings or partitions after his work has been installed. The material used for sealing the openings shall have a fire rating equal to or greater than the rating of the floor, ceiling or partition material.

G. Where present equipment is removed and unused openings remain in walls, floors, partition, etc., this Contractor shall properly patch all such openings except as hereinafter specified under "Work by Others". All patching and repairing shall be done by workmen skilled by this type of work and shall match present or new finishes.

H. Cutting, patching and repairing of openings in the existing exterior walls and roof shall be by this Contractor.

3.8 DISPOSAL OF REMOVED MATERIALS AND EQUIPMENT

A. The Owner shall be given the opportunity to retain ownership of any or all removed materials and equipment. All such items shall be carefully handled and protected and shall be stored by this Contractor at the site as directed by the Owner. Any such materials and equipment not desired by the Owner shall become the property of the Contractor and shall be removed promptly from the project site.

END OF SECTION 26 05 10

SECTION 26 05 19 - BUILDING WIRE AND CABLE

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 Sections includes the following:

1. Building wire and cable.

2. Mineral insulated metal sheath cable.

3. Metal clad cable.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 PROJECT CONDITIONS

A. Conductor sizes are based on copper.

B. Aluminum conductors for panel feeders shall be accepted as an Alternate Bid. Conductors must meet distance/voltage drop and ampacity requirements as designed for copper conductors. Contractor must submit revised cable sizing calculations for Alternate Bid

C. Wire and cable routing, where shown on drawings, is in approximate locations, unless dimensioned. Route wire and cable as required to meet Project Conditions.

D. Where wire and cable routing is not shown and destination only is indicated, determine exact routing and lengths to comply with the project requirements.

1.4 COORDINATION

A. Determine required separation between cable and other work.

B. Determine cable routing to avoid interference with other work.

1.5 SUBMITTALS

A. Submit under provisions of Section 260500.

B. Show fabrication and installation details of components for wire and cable.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. American Insulated Wire Corporation.

B. General Cable Corporation.

C. Southwire Company.

D. Prysmian Cables.

E. Cerro Wire and Cable Corporation.

2.2 BUILDING WIRE AND CABLE

A. Description: Single conductor insulated wire.

B. Conductor: 98 percent conductivity copper.

1. Cooper conductors only for branch circuits.

2. Copper conductors only for feeders smaller than 4 AWG.

3. Under alternate bid, aluminum conductors are acceptable for feeders 4 AWG and larger.
   a. Provide appropriate cable/conduit calculations for those locations where the alternate bid to use aluminum feeders is accepted. Design sizes as indicated on drawings are for copper conductors only.

C. Insulation Voltage Rating: 600 volts.

D. Insulation: ANSI/NFPA 70, Type THHN/THWN.

2.3 METAL CLAD CABLE

A. Description: ANSI/NFPA 70, Type MC.

B. Conductor: Copper.

1. Solid copper for 10 AWG and smaller.

2. Stranded copper for 8 AWG.

3. No conductor larger than 8 AWG is acceptable.

C. Insulation Voltage Rating: 600 volts.

D. Insulation Temperature Rating: 75 degrees Celsius.

E. Insulation Material: Thermoplastic.

F. Armor Material: Steel.

G. Armor Design: Interlocked metal tape or smooth tube.

H. Jacket - none.

I. Bending radius not to exceed requirements of NEC Article 330.24.

J. Supporting and securing at intervals not exceeding 6 feet; must be secured within 12 inches of an outlet box.

K. Fittings:

1. Manufacturer: Appleton Electric Products or equal.

2. Material: Steel or malleable iron.

2.4 MINERAL INSULATED METAL-SHEATHED

A. Description: Magnesium oxide insulation enclosed in a seamless, liquid and gas tight continuous copper sheath.

B. Conductor: Solid copper with high electrical conductivity.

C. Insulation: Minimum thickness of 55 mils for cable 14 AWG through 250 kcmil.

D. Size: Cross-section area shall correspond with standard AWG sizes.

E. Voltage Rating: 600 volts maximum.

F. Fire Rating: UL classified with a 2 hour fire rating.

G. Bending radius not to exceed requirements of NEC Article 332.24.

H. Supporting and securing at intervals not exceeding 3 feet.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that mechanical work likely to damage wire and cable has been completed.

3.3 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.4 WIRING METHODS

A. Concealed Inaccessible Dry Interior Locations: Use only building wire Type THHN/THWN insulation in raceway.

B. Exposed Dry Interior Locations: Use only building wire Type THHN/THWN insulation in raceway.

C. Above Readily Accessible Ceilings: Use only building wire Type THHN/THWN insulation in raceway.

D. Wet or Damp Interior Locations: Use only building wire Type THHN/THWN insulation in raceway.

E. Exterior Locations: Use only building wire Type THHN/THWN insulation in raceway.

F. Underground Locations: Use only building wire Type THHN/THWN insulation in raceway.

G. Motors, Transformers, Recessed Lighting Fixture Connections: Use only building wire Type THHN/THWN insulation in flexible metallic conduit.

H. Mineral insulated metal sheath cable shall be installed only where indicated on the drawings, and as indicated below:

1. When MI cables are cut in the field, ends will be sealed with standard PVC type sealing compound.

2. MI cables to be terminated with gland connector and seals as recommended by the cable manufacturer.

3. MI Cable may be splices in a junction box in accordance with manufacturer's recommendations.

4. MI cable shall be supported on trapeze hangers or supported directly to beams or ceilings using clips or straps available from the manufacturer.

I. Cord Drops: Type SO, hard service cord.

J. Metal clad cable shall be installed only as indicated below:

1. May be used in drywall partitions and above accessible ceilings.

2. May not be used in masonry partitions, masonry walls, or inaccessible ceilings.

3. May not be used for homerun circuits. Homeruns must be wire in conduit (EMT, IMC, RGS) from panelboard to a junction box in an accessible concealed ceiling space directly above or below the first utilization device or switch outlet.

4. In accessible ceiling spaces where MC cable is used, MC cable will be terminated at a junction box or pull box in the ceiling space of each room.

5. Install MC cable in lengths no longer than 12 feet, terminating at a junction box, wall box, device, or lighting fixture at each end.

6. MC cable run to switches shall have a neutral conductor.

7. Do not pass MC cable through to adjacent rooms.

K. Metal clad cable is not considered a raceway as defined by Article 100 of the NEC.

L. Insulated conductors and cables used where exposed to direct rays of the sun shall be of a type listed for sunlight resistance or listed and marked "sunlight resistant".

3.5 INSTALLATION

A. Install products in accordance with Manufacturer's instructions.

B. Use solid conductor for feeders and branch circuits 10 AWG and smaller.

C. Use stranded conductors for control circuits.

D. Use conductors not smaller than 12 AWG for power and lighting circuits. For all 120 volt branch circuits, the homerun from first outlet to panel shall be 12 AWG when run is 50 feet or

less, 10 AWG when run is between 50 feet and 100 feet, and 8 AWG when run is more than 100 feet. Wiring from first outlet to other outlets shall be 12 AWG minimum.

E. Use conductor not smaller than 14 AWG for control circuits.

F. Conductors shall not be smaller than the sizes indicated on the drawings.

G. Put all conductors into raceway at same time. Use pulling means including fish tape, cable, rope and basket-weave wire/cable grips that will not damage cables or raceways.

H. Use suitable wire pulling lubricant for building wire. Do not exceed Manufacturer's recommended maximum pulling tensions and sidewall pressure values.

I. Protect exposed cable from damage.

J. Support cables above accessible ceiling using spring metal clips or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.

K. Use suitable cable fittings and connectors.

L. Neatly train and lace wiring inside boxes, equipment and panelboards.

M. Clean conductor surfaces before installing lugs and connectors.

N. Make splices, taps and terminations to carry full ampacity of conductors with no perceptible temperature rise.

O. Use mechanical connectors for copper conductor splices and taps, 6 AWG and larger. The connector shall utilize 2 or more screw bolts to connect cables. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

P. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 8 AWG and smaller.

Q. Conductors shall be continuous from outlet to outlet. Splices shall only be made within outlet or junction boxes.

R. Color coding shall be as follows:

1. 120 volt, 2 wire circuit - grounded neutral, white; ungrounded leg, black.

2. 208/120 volt, 3 wire single phase circuit - grounded neutral, white; 1 hot leg, black and the other hot leg, red.

3. 208Y/120 volt, 3 phase, 4 wire - grounded neutral, white; 1 hot leg, black; 1 hot leg red and the other hot leg, blue.

4. 480Y/277 volt, 3 phase, 4 wire - grounded neutral, gray; 1 hot leg, yellow; 1 hot leg brown and the other hot leg, orange.

5. 480 volt, delta, 3 phase, 3 wire - 1 hot leg, yellow; 1 hot leg brown and the other hot leg orange.

6. All ground wires shall be green.

S. Colors shall be factory applied to the entire length of the conductors by 1 of the following methods:

1. Solid color compound.

2. Solid color coating.

T. Field applied color-coding method may be used in lieu of factory-coded wire in sizes larger than Number 8 AWG. Colored pressure-sensitive plastic or vinyl tape shall be applied in half overlapping turns for a distance of 6 inches for all terminal points and in all boxes in which conductors are accessible. The last 2 laps of tape shall be applied with no tension to prevent possible unwinding. Tape shall be 3/4 inch wide, 0.004 inches thick and colors shall be as hereinbefore specified. Tape shall be resistive to acids, alkalines, alcohol, chemicals and weathering. Cable identification markings shall not be obliterated by taping and tape location may be adjusted slightly to prevent obliteration of cable marking.

U. All conductors and cables shall be marked in accordance with NEC Article 310.11.

V. Provide conductor identification in accordance with NEC Article 310.12.

W. Cables and conductors installed in enclosures or raceways in underground installations shall be listed for use in wet locations.

3.6 INTERFACE WITH OTHER PRODUCTS

A. Identify wire and cable under provisions of Section 260553.

B. Identify each conductor with its circuit number or other designation indicated on Drawings.

3.7 FIELD QUALITY CONTROL

A. Perform field inspection and testing under provisions of Section 260500.

B. Inspect wire and cable for physical damage and proper connection.

C. Measure tightness of bolted connection and compare torque measurements with Manufacturer’s recommended values.

D. Verify continuity of each branch circuit conductor.

E. Perform each Electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.2.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING

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. Grounding Electrode System and Grounding Electrode Conductors.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 GROUNDING ELECTRODE SYSTEM

A. Metal underground water pipe.

B. Metal frame of the building or structure.

C. Concrete-encased electrode.

D. Rod and pipe electrodes.

E. Grounding Counterpoise.

F. Connectors and connections.

1.4 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 10 ohms.

1.5 SUBMITTALS

A. Submit under provisions of Section 260500.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

C. Test Reports: Indicate overall resistance to ground.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 260500.

B. Accurately record actual locations of grounding counterpoise.

1.7 COORDINATION

A. Coordinate work with site excavating, backfilling and final grading.

PART 2 - PRODUCTS

2.1 MANUFACTURERS – GROUNDING CONDUCTORS, CABLES AND RODS

A. Chance/Hubbell.

B. Erico, Inc.; Electrical Products Corporation.

C. Ideal Industries, Inc.

D. ILSCO.

E. Kearny/Cooper Power Systems.

F. Thomas + Betts, Electrical.

2.2 CONNECTION TO METAL UNDERGROUND WATER PIPE

A. Comply with requirements NEC Article 250.52 (A) (1).

2.3 CONNECTION TO METAL FRAME OF THE BUILDING OR STRUCTURE

2.4 CONCRETE-ENCASED ELECTRODE

A. Encased by at least (2 in.) of concrete within direct contact with earth.

B. Minimum steel reinforcing bar or rod size – 1/2 inch.

C. Minimum bare copper conductor size – Number 4 AWG.

2.5 ROD AND PIPE ELECTRODES

A. Minimum Length Size – 10 feet 0 inches.

B. Electrodes of rods of copper bonded steel minimum size – 3/4 inch diameter.

C. The Manufacturer and rod length shall be stamped in the surface near the rod top.

2.6 GROUNDING COUNTERPOISE

A. Three (3) ground rods spaced ten feet (10 feet) minimum on center. Rods shall be installed with top of rod 12 inches below finished grade.

B. Interconnect rods with a Number 4/0 copper ground wire, unless noted otherwise.

C. Interconnect counterpoise with the cold water system to the building with a Number 4/0 copper ground wire (unless noted otherwise) extended in 1 inch Schedule 40 PVC.

2.7 MECHANICAL CONNECTORS (Above Ground Connections)

A. Manufacturers:

1. Burndy (G-Series).

2. Anderson.

3. Teledyne Penn-Union.

4. Material: Bronze.

2.8 EXOTHERMIC CONNECTIONS (All Below Ground Connections)

A. Manufacturers:

1. Cadweld (Erico).

2. Thermoweld.

3. "Heavy duty" type.

B. Use the size mold as specified by the Manufacturer for each connection. Shim stock, wrap sleeves, or adapter sleeves shall not be used.

2.9 WIRE

A. Material: 4/0 AWG bare stranded copper, unless noted otherwise on drawings.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Verify completion of site backfill to where grounding work may commence.

3.3 INSTALLATION

A. Install Products in accordance with Manufacturer's instructions.

B. Bond the grounding counterpoise conductor entering the building with the incoming cold water metallic piping system in the building. Do not connect any bonding jumpers to water piping systems throughout the building except at one point.

C. Install grounding electrode conductor without splices in a separate PVC conduit from the point of connection at the grounding counterpoise to the system neutral in the main switchboard.

D. All surfaces of materials to be bonded shall be prepared according to Manufacturer's specifications. All surfaces involved shall be ground, filed or sanded to a bright clean condition. Apply a torch to the cable to remove any moisture and thus ensure the best possible connection.

E. Exothermic molds shall be inspected after each use of cleanliness and wear. Dirty molds shall be cleaned. Molds showing excessive wear or which cannot cleaned shall be discarded.

F. The system neutral shall be grounded to the grounding electrode system at the service entrance only, and shall be kept isolated from the building.

G. Metallic piping and duct systems that enter the building shall be grounded at the point of entry to the building, in accordance with the NEC.

H. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

I. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

J. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

K. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground 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. Comply with NEC Article 250.106.

3.4 INTERIOR GROUNDING AND BONDING

A. Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

B. Continuity of the building equipment grounding system shall be maintained throughout the project. Grounding jumpers shall be installed across conduit expansion fittings, all liquid-tight flexible metal conduit, light fixture pigtails, and all other non-electrically continuous raceway fittings.

C. All main grounding conductors shall be copper conductors, sized as shown on the drawings. The same conduit shall enclose grounding wire and electric circuit wires. All main grounding conductors shall be continuous without joints or splices over their entire length. No automatic cutout or switch shall be placed in the grounding conductor of the interior wiring system unless the opening of the cutout or switch disconnects all sources of energy. Where parallel equipment feeders are indicated and an equipment ground is used, a code size ground wire shall be extended in <u>each</u> feeder conduit.

D. Provide a ground conductor from the telephone service equipment to the building grounding system in a manner approved by the local utility company.

E. Where PVC conduit is used, a green ground wire sized as shown on the drawings shall be included in each conduit.

F. Grounding conductors and jumpers shall be connected to each other and to items to be grounded by means of compression connectors.

G. All electrical systems shall be suitably grounded, including all non-current carrying components of all equipment and metallic conduits.

H. The following equipment shall be grounded: all lighting fixtures, local control switches, receptacles, conduit system complete, motors, controls, panelboards, emergency generator, automatic transfer switches, all electric heating, ventilation and air conditioning equipment, water heaters, distribution switchboard, neutral conductor and transformers. Other equipment will be also grounded as required per NEC.

I. All connections to apparatus and conduits shall be made with an approved type of mechanical connector. Connectors shall be securely bolted or clamped to the equipment. All contact surfaces shall be thoroughly cleaned and bright before connections are made in order to insure a good metal-to-metal contact.

J. Distribution transformers and the emergency generators shall be grounded in accordance with the requirements of Sections 250-30 and 250-34 of the NEC.

K. Transformer secondaries shall be grounded in accordance with the requirements of Section 250-30 of the NEC.

L. All grounding conductors shall be identified by green color insulation unless indicated as being bare. Isolated ground conductors shall be identified by green color insulation with yellow stripe.

M. All grounding electrode conductors must be made within 5'-0" feet of where the water piping system enters the building, except where the water piping system is located in an industrial or commercial building that is serviced only by qualified persons and the entire length that will be used as an electrode is exposed, the connection may be made at any point on the water piping system.

N. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

O. Metal Water Service Pipe: Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

P. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

Q. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters and air cleaners. Use braided-type bonding straps.

R. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade or floor.

S. Connection at Test Wells: Use compression type connectors on conductors and make bolted and clamped type connections between conductors and ground rods.

T. Grounding Electrodes not Permitted for Grounding:

1. Metal underground gas piping system.

2. Aluminum electrodes.

U. Grounding electrode conductors installation shall comply with requirements of NEC Article 250.64.

V. Size of service entrances grounding conductor shall comply with requirements of NEC Article 250.66 and Table 250.66.

W. Bonding of services shall be in accordance with NEC Article 250.92.

X. Minimum size equipment grounding conductors shall be in accordance with NEC Article 250.122.

Y. Connection of grounding and bonding equipment shall comply with NEC Article 250.8.

Z. Grounding of 120/208V, 3Ø, 4 wire systems shall comply with NEC Article 250.20 (B) (2).

AA. Grounding service supplied systems shall comply with requirements of NEC Article 250.24.

BB. Main bonding jumper sizes shall not be less than required in NEC Article 250.28.

3.5 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

3.6 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

C. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the 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. Perform tests, by the fall-of-operational method according to IEEE 81.

END OF SECTION 26 05 26

SECTION 26 05 29 - SUPPORTING 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. This Section includes the following:

1. Conduit and equipment supports.

2. Fastening hardware.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

1.4 SUBMITTALS

A. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

PART 2 - PRODUCTS

2.1 MATERIAL

A. U-Channel Strut.

B. Clevis Hangers.

C. C-Clamps.

D. I-Beam Clamps.

E. One Hole Conduit Straps.

F. Two Hole Conduit Straps.

G. Round Steel Rods.

H. Lead Expansion Anchors.

I. Toggle Bolts.

J. Wall and Floor Seals.

K. NEC Compliance: Comply with the N.E.C. requirements as applicable to construction and installation of electrical supporting devices.

L. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports and equipment mounting.

M. UL Compliance: Provide electrical components that are UL listed and labeled.

N. FS Compliance: Comply with Federal Specification FF-S-760 pertaining to retaining straps for conduit, pipe and cable.

2.2 MANUFACTURED SUPPORTING DEVICES

A. General: Provide supporting devices that comply with Manufacturer's standard materials, design and construction in accordance with published product information and as required for complete installation and as herein specified. Where more than 1 type of supporting device meets indicated requirements, selection is Installer's option.

B. Supports: Provide supporting devices of types, sizes and materials indicated and having the following construction features:

1. Clevis Hangers: For supporting 2 inch rigid metal conduit; galvanized steel with 1/2 inch diameter hole for round steel rod.

2. Reducing Couplings: Steel rod reducing coupling, 1/2 inch by 5/8 inch; black steel.

3. C-Clamps: Black malleable iron; 1/2 inch rod size.

4. I-Beam Clamps: Black steel; 1 1/4 inch by 3/16 inch stock; 3/8 inch cross bolt; flange width 2 inches.

5. 1 Hole Conduit Straps: For supporting 3/4 inch rigid metal conduit; galvanized steel.

6. 2 Hole Conduit Straps: For supporting 3/4 inch rigid metal conduit; galvanized steel; 3/4 inch strap width and 2 1/8 inches between center of screw holes.

7. Hexagon Nuts: For 1/2 inch rod size; galvanized steel.

8. Round Steel Rod: Black steel; 1/2 inch diameter.

9. Offset Conduit Clamps: For supporting 2 inch rigid metal conduit; black steel.

C. Anchors: Provide anchors of types, sizes and materials indicated with the following construction features:

1. Toggle Bolts: Springhead; 3/16 inch by 4 inches.

2. Expansion sleeve anchors by Hilti or Philips Redhead - 1/2 inch.

3. Manufacturers: Subject to compliance with requirements, provide anchors of 1 of the following:
   a. Ackerman Johnson Fastening Systems Inc.
   b. Hilti.
   c. Ideal Industries, Inc.
   d. Joslyn Manufacturing and Supply Company.
   e. McGraw Edison Company.
   f. Phillips Redhead.
   g. Rawplug Company, Inc.

D. Sleeves and Seals: Provide sleeves and seals of types, sizes and materials indicated with the following construction features:

1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals of types and sizes indicated; suitable for sealing around conduit, pipe or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps and cap screws.

E. U-Channel Strut Systems:

1. Provide U-channel strut system for supporting electrical equipment, 12 gauge hot-dip galvanized steel with standard green finish and with the following fittings which mate and match with U-channel.
   a. Fixture hangers.
   b. Channel hangers.
   c. End caps.
   d. Beam clamps.

e. Wiring studs.
f. Thinwall conduit clamps.
g. Rigid conduit clamps.
h. Conduit hangers.
i. U-bolts.

2. Manufacturers: Subject to compliance with requirements, provide channel systems of 1 of the following:
a. Kindorf, Thomas & Betts.
b. Power-Strut Division; TYCO.
c. Unistrut Division; GTE Products Corporation.

2.3 FABRICATED SUPPORTING DEVICES

A. Pipe Sleeves: Provide pipe sleeves of one of the following:

1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snap lock joint, welded spiral seams or welded longitudinal joint. Fabricate sleeves from one of the following gauge metal: 3 inches and smaller, 20 gauge; 4 inches to 6 inches, 16 gauge; Over 6 inches, 14 gauge.

2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.

3. Iron Pipe: Fabricate from cast iron or ductile iron pipe.

4. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

B. Sleeve Seals: Provide modular mechanical type seals, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Fasten hanger rods, conduit clamps and outlet junction boxes to building structure using expansion anchors, preset inserts or beam clamps.

B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs and wood screws in wood construction.

C. Do not fasten supports to piping, ductwork, mechanical equipment or conduit.

D. Do not use powder-actuated anchors.

E. Do not drill structural steel members.

F. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

G. In wet locations install freestanding electrical equipment on concrete pads.

H. Install surface-mounted cabinets, equipment enclosures and panelboards with minimum of 4 anchors.

I. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

J. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

K. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports in compliance with NEC requirements.

L. Torque sleeve seal nuts, complying with Manufacturer’s recommended values. Ensure that sealing grommets expand to form watertight seal.

M. Remove burrs from ends of pipe sleeves.

END OF SECTION 26 05 29

SECTION 26 05 33 - CONDUIT

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. Metal conduit.

2. Electrical metallic tubing.

3. Flexible metal conduit.

4. Liquid tight flexible metal conduit.

5. Non-metal conduit.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTALS

A. Submit under provisions of Section 260500.

B. Show fabrication and installation details of components for raceways and fittings.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

1.4 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 260500.

B. Accurately record actual routing of conduits larger than 2 inches that are installed underground.

1.5 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.6 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Verify routing and termination locations of conduit prior to rough-in.

C. Conduit routing, where shown on the drawings, is in approximate locations unless dimensioned. Route as required to complete wiring system in accordance with this specification.

PART 2 - PRODUCTS

2.1 METALLIC CONDUIT

A. Manufacturers:

1. Allied Tube and Conduit Corporation.

2. O-Z Gedney.

3. Wheatland Tube Company.

2.2 METALLIC CONDUIT BODIES AND FITTINGS

A. Manufacturers:

1. Crouse Hinds Company.

2. O/Z Gedney.

3. Appleton Electric Company.

4. Thomas and Betts/Steel City.

2.3 FLEXIBLE CONDUIT

A. Manufacturers:

1. American Flexible Conduit.
2. Alflex Corporation.
3. Interflex.
4. International Metal Hose.

2.4 NON-METALLIC CONDUIT

A. Manufacturers:

1. Carlon.
2. Allied Tube & Conduit.
3. Arnco Corporation.
4. Cantex Inc.
5. Beck Manufacturing.
6. CertainTeed.

2.5 METAL CONDUIT

A. Rigid Steel Conduit: ANSI C80.1.

1. Minimum size – 3/4 inch.
2. Maximum size - 6 inches.

B. Intermediate Metal Conduit (IMC): ANSI C80.6.

1. Minimum size – 3/4 inch.
2. Maximum size - 4 inches.

C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; All fittings shall be steel. Conduit bodies shall be malleable iron.

D. All couplings and connections shall be of the threaded type.

E. Radius of conduit bends to comply with NEC Article 342.24, 344.24 and table 344.24.

2.6 ELECTRICAL METALLIC TUBING (EMT)

A. Description: ANSI C80.3; Unthreaded thin-wall raceway.

1. Minimum size - 1/2 inch.

2. Maximum size - 4 inches.

B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; Steel or malleable iron; compression type.

C. Radius of conduit bends to comply with NEC Article 358.24 and table 344.24.

2.7 FLEXIBLE METAL CONDUIT

A. Description: Interlocked steel construction.

1. Size to comply with NEC Article 348.20.

B. Fittings: ANSI/NEMA FB 1; Screw in type similar OZ/Gedney GCI Series.

C. Radius of conduit bends to comply with NEC Article 348.24 and table 344.24.

2.8 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Description: Interlocked steel construction with PVC jacket.

1. Minimum size - 1/2 inch.

2. Maximum size - 4 inches.

B. Fittings: ANSI/NEMA FB 1; Fittings to be similar to OZ/Gedney 4Q Series.

C. Radius of conduit bends to comply with NEC Article 350.24 and table 344.24.

2.9 NON-METALLIC CONDUIT

A. Description: NEMA TC2, Schedule 40 PVC (use Schedule 80 PVC only as directed on plans).

1. Minimum size - 1/2 inch.

2. Maximum size - 6 inches.

B. Fittings and Conduit Bodies: NEMA TC 3.

C. Radius of conduit bends to comply with NEC Article 352.24 and table 344.24.

2.10 WARNING TAPE

A. Detectable warning tape shall be red, 3 inches wide and shall consist of 1 layer of aluminum foil laminated between 2 layers of inert plastic film. It shall be resistant to alkalis, acids and other destructive agents commonly found in the soil. The lamination bond should be strong enough that the layers cannot be separated by hand. Tape shall be a minimum of 4.5 mils. thick with a minimum tensile strength of 60 pounds in the machine direction and 58 pounds in transverse direction per 3 inch wide strip. Tape shall be imprinted with a continuous warning message normally repeated every 16 to 36 inches. It shall be inductively locatable and conductively traceable using a standard pipe and cable locating device. Tape shall be installed parallel to and within 3” of conduit/ductbank centerline.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 CONDUIT LOCATION REQUIREMENTS

A. Minimum size acceptable for this project - 3/4 inch.

B. Underground Installations:

1. More than 5 feet from Foundation Wall: Use non-metallic conduit.

2. Within 5 feet from Foundation Wall: Use rigid steel conduit.

3. All changes in direction shall be made with manufactured bends with a minimum radius of 36 inches.

4. Maintain minimum spacing between conduits at 3 inches (6 inches between power and signal conduits).

5. All conduits shall be marked with warning tape.

6. In or Under Slab on Grade: Use rigid steel conduit.
   a. Use only to feed floor boxes.
   b. Minimum concrete cover for conduit is 3/4 inch.
   c. Maximum size conduit in slab is 1 inch.
   d. Must be installed above vapor barrier.

7. Minimum size: 3/4 inch.

C. Outdoor Locations, Above Grade: Use intermediate metal conduit.

D. In Slab, Above Grade:

1. Use rigid steel conduit.

2. Use only to feed floor boxes.

3. Minimum concrete cover for conduit is 3/4 inch.

4. Maximum Size Conduit in Slab is 1 inch.

E. Wet and Damp Locations: Use intermediate metal conduit.

F. Dry Locations:

1. Concealed: Use electrical metallic tubing.

2. Exposed: Use electrical metallic tubing.

G. Transformer Connections:

1. Flexible metal conduit.

2. Length - 42 inches maximum.

3. Size - same as conduit to which it is connected.

H. Motor Connections:

1. Liquidtight flexible metal conduit.

2. Length - 18 inches maximum.

3. Size - same as conduit to which it is connected.

I. Lighting Fixture Connections:

1. Flexible metal conduit.

2. Length - 72 inches maximum.

3. Size - 3/8 inch minimum.

3.3 INSTALLATION

A. Install conduit in accordance with NECA “Standard of Installation”.

B. Install non-metallic conduit in accordance with Manufacturer’s instructions.

C. Arrange supports to prevent misalignment during wiring installation.

D. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers and split hangers.

E. Group related conduits support using conduit rack. Construct rack using steel channel.

F. Fasten conduit supports to building structure and surfaces under provisions of Section 260529.

G. Do not support conduit with wire or perforated straps. Remove wire used for temporary supports.

H. Do not attach conduit to ceiling support wires.

I. Arrange conduit to maintain headroom and resent neat appearance.

J. Concealed in the construction except in portions of the building where it is impractical. At these locations the conduit shall be installed as inconspicuously as possible.

K. For IMC and RMC running threads shall not be used on conduit for connection at couplings. Use threaded couplings such as 3 piece type (union type) coupling. Use steel or malleable compression type couplings for EMT. Diecast couplings are not acceptable.

L. Route exposed conduit parallel and perpendicular to walls.

M. Route conduit in and under slab from point-to-point.

N. Do not cross conduits in slab.

O. Maintain adequate clearance between conduit and piping.

P. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104 degrees Fahrenheit (40 degrees Celsius).

Q. Cut conduit square using saw or pipe cutter; de-burr cut ends.

R. Bring conduit to shoulder of fittings; fasten securely.

S. Join non-metallic conduit using cement as recommended by Manufacturer. Wipe non-metallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes minimum.

T. Use electric hotbox bender to field bend non-metallic conduit.

U. Install internal support in all 2 inch diameter or larger non-metallic conduit before heating and bending to prevent crimping. Internal supports may be provided by filling the conduit with sand by using helical springs or by installing plugs in the ends of the conduit.

V. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations.

W. Each end of every conduit run terminating in a pressed steel box of any type shall be provided with a galvanized locknut and bushing inside and a locknut outside.

X. Use conduit bodies to make sharp changes in direction as around beams. Use hydraulic one-shot bender to fabricate bends in metal conduit larger than 2 inch size. Factory made elbows may be used.

Y. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

Z. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control, and expansion joints. Provide copper bonding jumpers across these fittings. Bonding jumper shall be of the same size as the ground wire within the conduit.

AA. Provide suitable pull string in each empty conduit except sleeves and nipples. Conduit shall be identified at both ends indicating destination and future use.

BB. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

CC. Ground and bond conduit under provisions of Section 260526.

DD. Identify conduit under provisions of Section 260553.

EE. Conduits in masonry walls shall be run in core of blocks. No horizontal conduit runs shall be made in tile or masonry walls.

FF. All conduit feeding outlets in demountable type partitions shall be run above the ceiling and down to the outlet as shown on the Drawings. No conduits shall be extended through floor for feeding these outlets.

GG. All underground conduits entering the building above finished floor shall be sealed with duct seal to prevent water entrance.

HH. Conduits installed underground and exterior to the building shall be installed at a minimum depth of 24 inches below finished grade, unless otherwise noted.

II. There shall not be more than the equivalent of 4 quarter bends (360 degrees total) between pull points.

JJ. Securing and supporting for IMC and RMC and EMT shall comply with NEC Article 342.30, 344.30 and 358.30 respectively.

KK. IMC, RMC and EMT conduit shall be marked with the letters IMC, RMC and EMT every 5 feet, 10 feet and 10 feet, respectively.

LL. Securing and supporting for flexible metal conduit and liquidtight flexible metal conduit shall comply with NEC Article 348.30 and 350.30, respectively.

MM. Securing and supporting for non-metallic conduit shall comply with NEC Article 352.30 and 352.44.

NN. Non-metallic conduit shall be marked every 10 feet.

OO. Cable wiring methods shall not be used as a means of support for other cables, raceways, or non-electrical equipment.

3.4 DELIVERY, STORAGE AND HANDLING

A. Accept conduit onsite. Inspect for damage.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

END OF SECTION 26 05 33

SECTION 26 05 34 - BOXES

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. Wall and ceiling outlet boxes.

2. Pull and junction boxes.

3. Floor boxes.

4. Poke-Thurs

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 260500.

B. Accurately record actual locations and mounting heights of outlet, pull and junction boxes.

1.4 PROJECT CONDITIONS

A. Verify field measurements are as shown on Drawings.

B. Verify locations of floor boxes and outlets prior to rough-in.

C. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose. Include installation within 10 feet of location shown. Prior to roughing in, the Owner may direct the Contractor to install any outlet within 10 feet of location shown on the drawings at no additional cost.

1.5 SUBMITTALS

A. Submit under provisions of Section 260500.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

C. Show fabrication and installation details of components for outlet, pull and junction boxes.

PART 2 - PRODUCTS

2.1 WALL AND CEILING OUTLET BOXES

A. Sheet Metal Outlet Boxes - Recessed: ANSI/NEMA OS 1, Galvanized steel.

1. Luminaire and Equipment Supporting Boxes: Shape and size shall suit type of fixture or canopy and be rated for weight of equipment supported. Include 1/2 inch male fixture studs where required.
   a. Luminaires weighing more than 23 kg (50 lb) shall be supported independently from the outlet box unless the outlet box is listed for the weight to be supported.

2. Minimum depth - 2 1/8 inches.

3. Concrete Ceiling Boxes - concrete type.

4. Provide 4 inch square boxes for fire alarm signaling devices and similar devices.

5. Manufacturers:
   a. Appleton.
   b. Raco/Hubbell.
   c. Steel City/Thomas & Betts.
   d. Walker.

6. Switch and Receptacle boxes shall be 4” square by 1.5” deep (metal stud walls), or 3.5” deep (masonry walls) with ¾” raised tile wall device covers finished flush with wall surfaces.

B. Cast Boxes - Surface Mounted: NEMA FB 1, Type FD cast feralloy. Provide gasketed cover by box Manufacturer. Provided threaded hubs.

C. Use cast outlet box in exterior locations and wet locations.

2.2 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

1. Cover: Furnish with machine screws.

2. Manufacturers:
   a. Hoffman.
   b. Robroy Industries, Inc.
   c. Walker Systems, Inc.
   d. O-Z/Gedney.

B. Surface-Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface-mounted junction box.

1. Material: Galvanized cast iron.

2. Cover: Furnish with ground flange, neoprene gasket and stainless steel cover screws.

C. In-Ground Cast Metal Box: NEMA 250, Type 6, inside flanged, recessed cover box for flush mounting.

1. Material: Galvanized cast iron.

2. Cover: Non-skid cover with neoprene gasket and stainless steel cover screws.

3. Cover Legend: ELECTRIC

2.3 FLOOR BOX / POKE THRU GENERAL

A. Floor boxes and poke thrus shall be provided with all accessories for a complete and first class installation.

B. Conduit entries shall be fire stopped with in tumescent material (minimum 2 hour rated fire stop putty system).

C. Class I and Class II cabling shall be compartmentally separated.

2.4 FLOOR BOX / POKE THRU COVERS

A. All floor box and poke thrus covers shall match is style, and finish.

B. Provide sizes as required.

C. Provide shims, rings and accessories as required for a complete and first class installation. Scrub water tightness shall be maintained. Seal around perimeter of poke-thru to maintain watertight seal.

D. Covers shall be brass.

E. Color to be selected by the Architect from manufacturer's full line of standard finishes as part of shop drawing approval process.

F. Carpet inserts shall not be used.

G. Covers shall be compatible with the floor type being installed. Tile, wood, and laminate floors shall utilize flush style covers. Carpet, finished concrete and terrazzo floor shall utilize surface style covers.

H. All boxes shall be provided with scrub water gasketing, designed for use with final floor type.

2.5 SINGLE SERVICE FLOOR BOX (ON-GRADE)

A. Floor box shall be provided with single power device, as required.

B. Cover shall be brass.

C. Manufacturers

1. Legrand 880 series.

2. FSR Equivalent.

3. Hubbell Equivalent.

2.6 2-GANG FLOOR BOX (ON-GRADE)

A. Floor box shall be compatible with power devices on the first floor only. Reference the plans for locations.

B. On-grade box shall be epoxy coated.

C. Cover shall be brass.

D. Manufacturers

1. Legrand RFSFB-OG with RP4CTC
2. FSR Equivalent
3. Hubbell Equivalent

2.7 2-GANG POKE THRU

A. Poke-thru shall be compatible with power devices on above grade floors. Reference plans for locations.

B. Cover shall have brass trim and black non-metallic cover.

C. Manufacturers

1. Legrand RC4STC with RC4CTC

2. FSR Equivalent

3. Hubbell Equivalent

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. See symbol legend on drawings for mounting heights.

B. Install electrical boxes where shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements. Set boxes true and square.

C. Install electrical boxes to maintain headroom and to present neat mechanical appearance.

D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

E. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel.

F. Install boxes to preserve fire resistance rating of partitions and other elements.

G. Use flush mounted outlet boxes in finished areas.

H. Do not install flush mounted boxes back-to-back in walls; provide minimum 6 inch separation. Provide minimum 24 inches separation in acoustic or fire rated walls.

I. Secure flush mounted box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

J. Use stamped steel bridges to fasten flush mounted outlet box between studs.

K. Install flush mounted box without damaging wall insulation or reducing its effectiveness.

L. Use adjustable steel channel fasteners for hung ceiling outlet box.

M. Do not fasten boxes to ceiling support wires.

N. Support boxes independently of conduit.

O. Use gang box where more than 1 device is mounted together. Do not use sectional box.

P. Use gang box with plaster ring for single device outlets.

Q. Set floor boxes level.

R. All metal boxes shall be grounded in accordance with the NEC Article 250.

S. The number of conductors in outlet, devices and junction boxes and conduit bodies shall comply with NEC Article 314.16.

T. Outlet boxes shall be permitted to support luminaries weighing 50 pounds or less. If luminaire weighs more than 50 pounds it shall be supported independently from the outlet box unless the outlet box is listed for the weight to be supported.

U. For systems under 600 volts, raceways containing conductors of 4 AWG or larger and for cables containing conductors of 4 AWG or larger, the minimum dimensions of pull or junction boxes installed in a raceway or cable run shall comply with the following:

1. In straight pulls, the length of the box shall not be less than 8 times the trade size of the largest raceway.

2. Where splices or where angle or U pulls are made, the distance between each raceway entry inside the box and the opposite wall of the box shall not be less than 6 times the trade size of the largest raceway in a row. The distance shall be increased for additional entries by the amount of the sum of the diameter of all other raceway entries in the same row on the same wall of the box. Each row shall be calculated individually and the single row that provides the maximum distance shall be used.

END OF SECTION 26 05 34

SECTION 26 05 35 - SURFACE RACEWAYS

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. Surface metal raceways.

2. Wireways.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTALS

A. Submit under provisions of Section 260500.

B. Product Data: Provide dimensions, knockout sizes and locations, materials, fabrication details, finishes and accessories.

C. Manufacturer’s Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation and installation of Product.

D. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation.

PART 2 - PRODUCTS

2.1 SURFACE METAL RACEWAY

A. Manufacturers:

1. Wiremold.
2. Hubbell.
3. Mono-Systems.

B. Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

1. One piece, Wiremold 700 or equal.
2. Two piece, Wiremold 2400 or equal.
3. Two piece, two channel, Wiremold 4000 or equal.
4. Finish: Buff enamel.

C. Fittings, Boxes and Extension Rings: Furnish Manufacturer's standard accessories.

D. Surface metal raceways shall be installed only when indicated on the Drawings. Type of surface metal raceway as indicated.

2.2 WIREWAY

A. Manufacturers:

1. Wiremold.
2. Walker.
3. Square D.
4. Hoffman.

B. Description: General purpose type wireway.

C. Knockouts: Manufacturer's standard.

D. Size and length as indicated on the Drawings.

E. Size as indicated on the Drawings.

F. Cover: Screw cover.

1. Connector: Flanged.

2. Fittings: Lay-in type with removable top, bottom and side; captive screws.

G. Finish: Rust inhibiting primer coating with gray enamel finish.

H. Securing and supporting of wireway shall be in accordance with NEC Article 376.30.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Install products in accordance with Manufacturer's instructions.

B. Use flat-head screws, clips and straps to fasten raceway channel to surfaces. Mount plumb and level. Secure to building structures with anchor bolts on 3 foot centers (maximum).

C. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

D. Wireway Supports: Provide steel channel as specified in Section 260529.

E. Close ends of wireway and unused conduit openings.

F. Ground and bond raceway and wireway under provisions of Section 260526.

G. When combination surface metal raceways are used both for signaling and lighting and power circuits, the different systems shall be run in separate compartments identified by sharply contrasting colors of the interior finish and the same relative position of compartments shall be maintained through the premises.

END OF SECTION 26 05 35

SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

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. Nameplates and Tape Labels.

2. Wire and Cable Markers.

3. Panelboard Directories.

4. Conduit Color Coding.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTALS

A. Submit shop drawings under provisions of Section 260553.

B. Include schedule for nameplates.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Brady Manufacturer Corporation.

B. Seton Nameplate Corporation.

C. Thomas and Betts Corporation.

2.2 MATERIALS

A. Nameplates:

1. Engraved three-layer laminated plastic, black letters on a white background for normal distribution equipment; black letters on a yellow background for emergency distribution equipment. Background color of nameplates for other systems shall correspond to the color coding schedule.

B. Tape Labels: Adhesive-backed pressure sensitive; factory printed on plastic of color as identified in the color coded schedule or field assembled from individual numerals and symbols. Embossed “Dymo” type labels are not acceptable.

C. Wire and Cable Markers: Cloth markers, split sleeve or tubing type.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Degrease and clean surfaces to receive nameplates.

B. Install nameplates parallel to equipment lines.

C. Secure nameplates to equipment fronts using screws, rivets or adhesive. Secure nameplate to inside face of recessed panelboard doors in finished locations.

D. Embossed tape will not be permitted for any application.

3.3 WIRE IDENTIFICATION

A. Provide wire markers on each conductor in panelboard gutters, pull boxes, junction boxes and at load connection. Identify with branch circuit or feeder for power and lighting circuits and with control wire number as indicated on equipment manufacturer's shop drawings for control wiring.

3.4 NAMEPLATE ENGRAVING SCHEDULE

A. Provide nameplates of minimum letter height as scheduled below.

B. Panelboards, Switchboards and Motor Control Centers: ½ inch; identify equipment designation; ¼ inch; identify voltage rating and source.

C. Main and Individual Circuit Breakers in Distribution Panelboards and Switchboards: ¼ inch; identify circuit and load served, including location.

D. Individual Enclosed Circuit Breakers, Thermal Switches for ATC Controlled Fans, Contactors, Disconnect Switches and Combination Start/Disconnect Switches: ¼ inch; identify load served.

E. Transformers: ½ inch; identify equipment designation; ¼ inch; identify primary and secondary voltages, primary source and secondary load and location.

F. Junction Boxes and Boxes in Panel Feeders: ¼ inch; identify circuit number and load served.

G. Automatic Transfer Switches: ½ inch; identify equipment designation; ¼ inch; identify voltage rating and source.

3.5 PANELBOARD DIRECTORIES

A. Provide typed directory in all new panelboards indicating the room number or area, and the item or items controlled by each circuit. Coordinate with the Owner as to what the correct room number will be once the building is occupied.

B. Provide revised typed directory in existing panelboard when required by project conditions.

C. Provide labels at switches or circuit breakers on switchboards identifying as to the load served.

3.6 IDENTIFICATION OF RACEWAYS AND OUTLET BOXES

A. Outlet and junction box covers in ultimately unfinished and concealed spaces shall be painted to identify system function in accordance with the color coding schedule below.

B. Outlet, pull and junction box covers shall be clearly marked with tape labels to identify the panel and circuit numbers of all circuits contained within, or with the name of the system. In concealed areas, indelible marking pens may be used in lieu of tape labels. All identification shall be performed after completion of finish painting.

C. Raceways shall be marked no greater than 50 feet on center with colored paint markings to identify system function in accordance with the color coding schedule below.

D. Receptacles on emergency or normal/emergency service shall be provided with faceplates engraved with ¼ inch lettering filled with red enamel to read “EMERGENCY”.

3.7 COLOR CODING SCHEDULE

A. Primary Distribution: Magenta with white markings no greater than 30 feet on center reading “HIGH VOLTAGE”.

1. 480/277 volts and 208/120 volts; Normal Service, natural (not painted).

B. Emergency (and Normal/Emergency) Service: Yellow.

C. Uninterruptible (UPS) Service: Blue.

D. Fire Alarm System: Red with 1 inch tape label “FA”.

E. Telephone System: Green.

F. Public Address System: Orange.

G. Motor and Other Control Systems: Brown.

END OF SECTION 26 05 53

SECTION 26 05 74 - ELECTRICAL SYSTEM TESTS

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. Field acceptance and operational testing of all electrical equipment and systems.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 QUALITY ASSURANCE

A. Test materials and methods shall conform to all applicable codes, the requirements of authorities having jurisdiction and the latest edition of reference standards published by the organizations listed in Section 260500 applicable to the work of this section.

B. Test instrument calibration in accordance with NETA ATS.

1.4 SUMITTALS

A. Submit in accordance with Section 260500.

B. Proposed testing schedule.

C. Certified test reports. Refer to specific test descriptions for additional information regarding data to be included in test reports.

1.5 GENERAL REQUIREMENTS FOR TESTING

A. Retesting required as a result of malfunction or failure of equipment to meet specified performance criteria shall be performed at no additional cost to the Owner.

B. Where possible, malfunctioning equipment shall be corrected at the site and retested; otherwise, equipment shall be replaced with new equipment and retesting shall proceed.

C. Upon satisfactory completion of these tests, the Contractor shall furnish, for each item of equipment or system tested, a written statement certifying that there has been no invalidation of any warranties or impairment of the capacity or functionality of the equipment or system tested.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide all equipment required to conduct tests as specified herein, including any specialized test equipment recommended by a system manufacturer.

B. The tests shall be conducted by:

1. I.E.T., Inc., PO. Box 326, Dauphin Pennsylvania, (717) 921-8993

2. MET Electrical Testing Company, Inc., 3700 Commerce Drive, Suite 901-903, Baltimore Maryland, 21227, (888) 638-8378

3. Cable Testing Service, Inc., 27G Albe Drive, Newark, DE 19702, (302) 369-5420 or 1-800-624-1600.

2.2 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer. By using the equipment manufacturer the study allows coordination of proper breakers, fuses, and current transformers. The coordination study shall begin with the Electrical Power Utilities (BG&E) transformer secondary and include all of the electrical protective devices down to and including, but not limited to: main low voltage switchboard, distribution switchboards, down to the 208 volt utilization branch panelboards. The study shall also include emergency generator and associated distribution panelboards down to the 208 volt branch panelboards. The designed available fault current at the new utility transformer secondary is 21,873 amps. Prior to evaluation, confirm available fault current with BG&E based on project conditions.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

2.3 DATA COLLECTION

A. Contractor shall furnish all field data as required by the power system studies. The sub-contracted Professional Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Include fault contribution of motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required equipment data, if necessary, to satisfy the study requirements.

2.4 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.

B. Transformer design impedances and standard X/R ratios shall be used when test values are not available.

C. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted
4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Typical calculations
6. Tabulations of calculated quantities
7. Results, conclusions, and recommendations

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
1. Low voltage switchboard
2. Generators and automatic transfer switches
3. Branch circuit panelboards
4. Other significant locations throughout the system

E. 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.

F. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchboards and panelboard bus bracing to withstand short-circuit stresses
3. Adequacy of transformer windings to withstand short-circuit stresses
4. Cable sizes for ability to withstand short-circuit heating
5. Calculate maximum current to ground at the new equipment building and confirm the ground conductors can withstand the maximum ground fault current before actuation of ground fault units and breaker tripping.

2.5 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.

B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the curve sheets, where applicable:

1. Electric utility’s protective device
2. Low voltage equipment relays-utility, bus, and generator
3. Medium and low voltage fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer’s tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points
9. Pertinent generator short-circuit decrement curve and generator damage point
10. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.6 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all 480volt locations and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at two (2) seconds based on IEEE 1584-2002 section B.1.2.

2.7 REPORT SECTIONS

A. Input Data:

1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
2. Short-circuit reactance of rotating machines with associated X/R ratios
3. Cable type, construction, size, # per phase, length, impedance and conduit type
4. Bus duct type, size, length, and impedance
5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
6. Reactor inductance and continuous ampere rating
7. Aerial line type, construction, conductor spacing, size, # per phase, and length

B. Short-Circuit Data:

1. Source fault impedance and generator contributions
2. X to R ratios
3. Asymmetry factors
4. Motor contributions
5. Short circuit kVA
6. Symmetrical and asymmetrical fault currents

C. Recommended Protective Device Settings:

1. Circuit Breakers:

a. Adjustable pickups and time delays (long time, short time, ground).
b. Adjustable time-current characteristic.
c. Adjustable instantaneous pickup.
d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations.

1. Arcing fault magnitude
2. 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

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 SCHEDULING

A. Notify the Professional 2 weeks prior to testing. Scheduling of all tests shall be approved by the Professional.

B. Schedule tests so as not to interfere with the overall progress of the job.

C. Schedule tests so that equipment may be energized immediately after completion of testing and approval of reports.

3.3 PREPARATION

A. Examine the Contract Documents to ensure the completeness of all Work prior to testing.

B. Megger and high potential testing shall not be performed during periods of high relative humidity. A guard shall be stationed at each location where exposed cables, buswork, connections or other components exist during megger and high potential testing.

C. All equipment shall be thoroughly cleaned prior to testing. Vacuum the interiors of all cabinets and equipment cubicles and remove all foreign material. Wipe all insulators, bushings and bus supports clean with a lint free cloth.

D. Preliminary tests and visual inspections of the electrical installation including verification checks of factory wiring shall be conducted prior to electrical acceptance and operational tests to avoid delays, and to assure that equipment and installations are free of faulty conditions prior to the application of test voltages.

E. Where the equipment or system under test is interconnected with or dependent upon other equipment, systems and/or controls for proper operation, the latter shall be operated simultaneously with the equipment or system under test to verify proper functioning of all interfaces.

F. Verify that all shipping materials and restraints have been removed from equipment.

G. Check for proper tightness at all connections of shipping sections.

3.4 WIRING SYSTEM TESTS (600 VOLTS AND LESS)

A. Wire and cable shall be tested for continuity, freedom from short circuits and grounds and meggered to assure adequate insulation resistance for each conductor.

B. Megger instrument shall apply 1000 volts DC for 1 minute.

C. Insulation resistance between any 2 phase conductors and any phase conductor to ground shall be not less than 2 meggohms for connected conductors and 100 megaohms for disconnected conductors.

D. Submit schedule of test results for all feeders rated at 100 amps or greater. Schedule shall indicate feeder designation, load served, feeder size, feeder length and measured values for each conductor. Individual values shall be recorded for each conductor of multiple phase circuits.

E. Visual and Maintenance Inspection:

1. Inspect each individual exposed power cable number 6 AWG and large for:
   a. Physical damage.
   b. Proper connections in accordance with single line diagram.
   c. Cable bends not in conformance with manufacturer’s minimum allowable bending radius where applicable.
   d. Color-coding conformance with specifications.
   e. Proper circuit identification.

2. Mechanical Connections for:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by Manufacturer.

3. Shielded Instrumentation Cables for:
   a. Proper shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.

4. Control Cables for:
   a. Proper termination.
   b. Proper circuit identification.

3.5 GROUNDING SYSTEM TESTS

A. Tests on the grounding system shall be made after complete installation and interconnection of the ground system elements including individual ground rods, ground counterpoise or grid cables, connections to structural steel, reinforcing bars, incoming water piping, ground busses on walls and within equipment, etc.

B. Test the grounding system for continuity by applying a low voltage DC source of current, capable of providing up to 100 amperes. The ground path using structural steel must conduct 100 amperes. Resistance as calculated from the current and voltage shall not exceed 0.25 ohms.

C. Test the completed equipment grounding system at each distribution panel, motor control center and branch circuit panelboard. Ground resistance shall not exceed 5 ohms at any piece of distribution equipment and 10 ohms at any item of utilization equipment. Ground resistance tests at distribution equipment shall be made in accordance with the procedures described in James G. Biddle Company Bulletins 25-T2 and 25-J and in accordance with IEEE 81, Section 8.2.1.1 and 8.2.1.5.

D. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in panelboard assemblies for proper connection and tightness.

2. Effective transformer care and equipment grounding.

3. Accessible connections to grounding electrodes for proper fit and tightness.

3.6 DISTRIBUTION EQUIPMENT TESTS

A. All distribution equipment shall be tested for continuity, freedom from short circuits and grounds and meggered to assure adequate resistances.

B. Megger instrument shall apply 1000 volts DC for equipment rated 480 or 600 volts and 500 volts DC for equipment rated 250 volts; applied for 1 minute.

C. Insulation resistance between any 2 phases and any phase to ground shall be not less than 100 megohms for equipment rated 480 or 600 volts and 25 megohms for equipment rated 250 volts.

D. Measure load current on each phase of panelboards serving single phase loads. Rearrange branch circuits to balance phases to within +/-10 percent of the average load. Maintain proper phasing of trunked branch circuit homeruns.

E. Perform an insulation resistance test at 1000 volts DC on each circuit breaker for 1 minute from pole-to-pole and from pole-to-ground with the breaker closed and across open contacts of each phase. Insulation resistance shall not be less than 100 megaohms.

F. Set, calibrate and adjust protective device settings of each circuit breaker in accordance with the approved coordination study using secondary current injection.

G. Verify proper wiring and polarity of all ground fault protection devices. Verify proper operation and performance of zone-selective interlocking schemes by simulating a ground fault condition.

3.7 ELECTRICAL ACCEPTANCE TESTS

A. The Contractor shall engage the services of a recognized independent testing agency to perform certain electrical tests as herein specified. The testing agency shall be responsible to do the specified electrical tests in total compliance with the specification of the National Electrical Testing Association (NETA). The Electrical Contractor shall be responsible to do visual and mechanical inspections as well as megger tests as detailed herein and in total compliance with the specifications of NETA. The Electrical Contractor shall certify in writing that the visual and mechanical inspections were completed and the results of those inspections.

B. The testing agency shall provide all material, equipment, labor and supervision required to conduct the electrical tests.

C. It is the intent of these inspections and tests to determine the suitability for reliable operation of certain electrical facilities and upon completion, a label shall be attached to all items included in this scope of work. These labels shall indicate the date of tests and the agency responsible for conducting the tests.

D. As copyrighted by NETA, the responsibility of the testing laboratory and the Contractor shall be as follows:

1. The Contractor shall perform routine resistance, continuity and rotation tests for main distribution and utilization equipment prior and in addition to tests performed by the testing agency specified herein. The Contractor shall also perform the specified visual and mechanical inspections.

2. The Contractor shall supply a suitable and stable source of test power to the test laboratory at each test site. The testing agency shall specify requirements.

3. The Contractor shall notify the testing agency when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

4. The Contractor will supply a complete set of electrical plans, specifications and any pertinent change orders to the testing agency prior to commencement of testing.

5. The testing agency shall notify the Professional prior to commencement of any testing.

6. Any system, material or workmanship which is found defective on the basis of acceptance tests shall be reported directly to the Professional.

7. The testing agency shall maintain a written record of all tests and upon completion of project, assemble and certify a final test report.

E. Test Instrument Traceability:

1. The testing agency shall have a calibration program which maintains all applicable test instrumentation within rated accuracy.

2. The accuracy shall be traceable to the National Bureau of Standards in an unbroken chain.

3. Instruments shall be calibrated in accordance with the following frequency schedule:
   a. Field instruments - 6 months maximum.
   b. Laboratory instruments - 12 months.
   c. Leased specialty equipment - 12 months (where accuracy is guaranteed by lessor, i.e. Doble).

4. Date calibration labels shall be visible on al test equipment.

5. Records must be kept up-to-date which show date and results of all instruments calibrated or tested.

6. An up-to-date instrument calibration instruction and procedure will be maintained for each test instrument.

F. Test Report:

1. The test report shall include the following:
   a. Summary of project.
   b. Description of equipment tested.
   c. Description of test.
   d. Test results.
   e. Conclusions and recommendations.
   f. Appendix, including appropriate test forms.
   g. List of test equipment used and calibration date.

2. Furnish 3 copies of the completed report to the Professional no later than 30 days after completion of the tests.

G. Applicable Codes, Standards and References:

1. All inspection and tests shall be in accordance with the following applicable codes and standards except as provided otherwise herein.
   a. National Electrical Code - NEC.
   b. National Electrical Manufacturer’s Association - NEMA.
   c. American Society for Testing and Materials - ASTM.

d. Institute of Electrical and Electronic Engineers - IEEE.
e. National Electrical Testing Association - NETA.
f. American National Standards Institute - ANSI.
g. State and Local Codes and Ordinances.
h. Insulated Power Cable Engineers Association - IPCEA.
i. Association of Edison Illuminating Companies - AEIC.
j. OSHA Part 1910; Subpart S, 1910.308.
k. National Fire Protection Association - NFPA.

2. All devices and materials to perform the tests must be obtained prior to commencing the work.
   a. All instruments must be available and in proper operating condition.
   b. All dispensable materials such as solvents, rags and brushes required must be provided.
   c. All equipment handling devices such as vehicles, chain falls and other lifting equipment must be available or scheduled.
   d. All instruction books, calibration curves or other printed material to cover the electrical devices must be available.
   e. Data sheets to record all rest results must be available before the work is started.

3. All inspections and tests shall utilize the following references:
   a. Project design specifications.
   b. Project design drawings.
   c. Manufacturer’s instruction manuals applicable to each particular apparatus.

H. Safety and Precautions:

1. Safety practices shall include, but are not limited to, the following requirements:
   a. Occupational Safety and Health Act of 1970 - OSHA.
   b. Accident Prevention Manual for Industrial Operations, Seventh Addition, National Safety Council, Chapter 4.
   c. Applicable State and Local Safety Operating Procedures.
   d. NETA Safety/Accident Prevention Program.
   e. Owner’s Safety Practices.
   f. National Fire Protection Association - NFPA 70E.

2. All tests shall be performed with apparatus de-energized except where otherwise specifically required by NETA.
   a. Field coordinate shut-down with Owner to minimize interruption to their normal operations.

3. The testing agency shall have a designated safety representative who shall be present on the project and supervise operations with respect to safety.

4. Power circuits shall have conductors shorted to ground by a hot-line grounded device approved for the purpose.

5. In all cases, work shall not proceed until the safety representative has determined that it is safe to do so.

6. The testing agency shall have available sufficient protective barriers and warning signs to conduct specified tests safely.

I. The following items of equipment shall be tested in accordance with NETA Specifications. All listed items shall have the NETA recommended visual and mechanical inspections performed by the Electrical Contractor. The testing agency shall perform the electrical tests noted.

1. One 480/277 volt, 2000A main circuit breaker

2. Low voltage switchboard consisting of:
   a. One 480 volt distribution sections (MDS) consisting of:
      1) Main lugs.
      2) All feeder circuit breakers.
   b. One 480 volt panelboard sections (SMDS) consisting of:
      1) One 1000A main breaker (100% rated)
      2) All feeder circuit breakers.
   c. DC high potential tests.
   d. Instantaneous pickup current tests by regroup or pulse method.

3.8 FAULT PROTECTION AND COORDINATION STUDY

A. The complete coordination study for system protection to be performed by the testing company as specified herein before in this Section. Fault current calculations to be provided for the entire system.

1. The fault protection and coordination study shall include the following information:
   a. Calculated available fault currents at all equipment busses and overcurrent protective devices in the system. Values shall be calculated for 3 phase bolted fault conditions. The current limiting effects of fuses shall be demonstrated in the report.
   b. Complete sets of time-current coordination curves, starting with devices at the point of service through to the branch devices in each item of equipment at the lowest levels of the distribution system.
   c. A complete set of motor starting time-current curves for motors exceeding 50 horsepower based on the Wk^2 inertia of the driven load.
   d. A complete set of transformer inrush and thermal withstand curves.
   e. A tabulation of all recommended relay settings including ground fault relay settings, fuse sizes and classes and circuit breaker trip settings; identifying each item by Manufacturer and catalog number.

2. Selective Coordination:
   a. A tabulation of all necessary revisions and/or additional equipment required to achieve full selective coordination for the emergency life safety system, as required by 2011 NEC.
   b. A tabulation of any cases where selective coordination is not obtainable and a description of the consequences of a downstream fault on continuity of service.

B. IMPLEMENTATION OF RECOMMENDATIONS

1. Upon approval of the final study by the testing company, the Contractor shall adjust protective device settings for new and existing protective devices in the affected equipment in accordance with the values recommended in the report.

2. Upon approval of the final study by the testing company, the Contractor shall implement all recommendations included in the report to ensure that full selective coordination is achieved as per Articles 620.62, 700.27, 701.18 and 708.54 of the 2011 National Electrical Code.

3. The final selection of protective devices for all new equipment furnished under this Contract shall be based on the approved study.

4. The completed coordination study must be approved prior to final approval of any electrical distribution equipment to insure any recommended changes in order to achieve the appropriate coordination level are implemented prior to the manufacture and release of equipment.

3.9 ARC FLASH WARNING LABELS

A. The Contractor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The label shall have an orange header with the wording, “WARNING, ARC FLASH HAZARD”, and shall include the following information:

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 markings

D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided
2. For each low voltage switchboard, one arc flash label shall be provided

E. Labels shall be field installed by the Contractor under the supervision of the Professional Engineering Company.

END OF SECTION 26 05 74

SECTION 26 09 20 - CONTACTORS

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. General purpose contactors.

2. Lighting contactors.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTALS

A. Submit under provisions of Section 26 05 00.

B. Product Data: Include dimensions, size voltage ratings and current ratings.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

1.4 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of each contactor and indicate circuits controlled.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 260500.

B. Maintenance Data: Include instructions for replacing and maintaining coil and contacts.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D.

B. General Electric.

C. EATON/Cutler Hammer

2.2 CONTACTORS

A. Description: Magnetic lighting contactor.

B. Configuration: As scheduled on drawings. Mechanically held and electrically operated with encapsulated coils. Standard coil clearing contacts are to be provided so that the contactor coils shall be energized only during the instance of operation.

C. Coil Voltage: As scheduled on drawings - 60 Hz.

D. Poles: As scheduled on drawings.

E. Contact Ampere Rating: As scheduled on drawings for all types of ballast and tungsten lighting, resistive heating and motor loads.

F. Contacts: Totally enclosed, double-break silver cadmium oxide power contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring.

G. Wiring: Straight-through wiring with all terminals clearly marked.

H. Enclosure: ANSI/NEMA ICS 6, Type as indicated.

I. Comply with UL listed 508 and NEMA 1CS 2.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install contactors plumb. Provide supports in accordance with Section 260529.

C. Height: 5 feet (1.6 Meters) to operating handle.

3.3 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.16.1.

END OF SECTION 26 09 20

SECTION 26 09 33 - LIGHTING - PRESET AND DIMMING CONTROL 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:

1. Integrated, multi-preset, modular dimming controls.
   a. Media Center Lighting
   b. Dining Area Lighting
   c. Collaborative Stair Lighting

2. Multi-zone lighting control/dimming panels.
   a. All individual classrooms
   b. As required for typical office/work spaces that require multi-level dimming

3. Networked lighting control modules/panels
   a. Corridor lighting
   b. Stair lighting
   c. Exterior building mounted lighting
   d. Exterior parking lot/pedestrian lighting

4. Wallstation controls

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

3. Division 26 Section “Wiring Devices and Wall Plates” for sensor requirements.

1.3 SUMMARY

A. Furnish and install a complete system for the control of lighting and other equipment as indicated on the plans, detailed in the manufacturer submittal and as further defined herein. Contractor is solely responsible to verify quantity, installation locations and wiring requirements for this project. Specific catalog numbers when listed in this section are for reference only. It is the responsibility of the contractor to verify with the lighting control manufacturer all catalog information and specific product acceptability.

B. System shall include, but not be limited by the following list: Pre-assembled dimming and switching panels with digital switches and digital time clocks, low-voltage wall stations and/or control interfaces, and solid-state high frequency fluorescent dimming ballasts (where applicable), 0-10V LED dimming control. Additional items may also be required and are described herein and/or shown on the drawings.

C. The lighting control system shall communicate via RS485. The system must be able to communicate with fully digital centralized relay panels, zone control panels, digital switches, modular dimming control systems, other various interfaces and shall include all operational software and hardware necessary for a complete system. Software to be resident within the lighting control system. System shall provide local access to all programming functions at the master LCP and remote access to all programming functions via dial-up modem and through any standard computer workstation running and industry standard internet browser. Lighting control system shall have server built into the master LCP that "serves" HTML pages to any authorized workstation. Desktop computers are not part of this section and will be provided by others. Non-networked, non-digital, non-server capable systems are not acceptable.

D. System software shall provide real time status of each relay, zone or group.

E. The lighting control system shall be able to be monitored by and take commands from a remote PC. At any time, should the remote PC go off-line, all systems programming uploaded to the lighting control system shall continue to operate as intended. System requiring an on-line PC or server for normal operation are not acceptable.

F. All programs, schedules, time of day, etc., shall be held in non-volatile memory for a minimum of 10 years at power failure. At restoration of power, lighting control system shall implement programs required by current time and date.

G. Extent of each type of preset lighting control system is indicated on drawings and by provisions of this section.

H. Work under this section consists of the furnishing of all labor, materials, equipment and services necessary for, and incidental to, the complete and proper installation of preset lighting control systems and related work as shown on the drawings or specified herein, and in accordance with all applicable requirements of the Contract Documents.

I. The material and installation shall conform to the applicable building code requirements of all authorities having jurisdiction.

1.4 QUALITY ASSURANCE

A. Materials and equipment shall conform to all applicable codes, the requirements of authorities having jurisdiction and the latest edition of reference standards published by the organizations listed in Section 260500 applicable to the work of this section.

B. Reference Standards

1. The reference standards applicable to work of this section shall include, but not be limited to, the following:
   a. UL 486A
   b. Wire Connectors and Soldering Lugs for use with Copper Conductors.
   c. ANSI.
   d. IEEE.
   e. NEMA 250
   f. Enclosures for Electrical Equipment (1000 Volts Maximum).
   g. NFPA 70.

C. Manufacturer's Qualifications

D. The Manufacturer shall be a firm regularly engaged in the manufacture of preset lighting control systems whose products have been in satisfactory use in similar application for a period of not less than 5 years.

1.5 SUBMITTALS

A. General:

1. Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

   Product Data:

B. Include dimensions and data on features, components, and ratings for dimming controls. Include elevation views of front panels of control and indicating devices and control stations. Also include the following:

C. List of ballasts and lamp combinations compatible with dimmer controls, by Manufacturer and catalog number.

D. Sound data, including results of operational tests of dimming controls.

E. Operational documentation for software and firmware.

1. Shop Drawings

2. Including equipment layouts, detailed point-to-point wiring diagrams, and sequence of operations.

3. Dimming load schedule indicating a clear understanding of the actual loads per circuit, which circuits are on their respective control zones, which circuits are on emergency (if applicable), and the corresponding circuit numbers (per the electrical drawings).

4. Interconnection diagram

5. Showing a detail of each control, which zones are on that control, the interconnecting wiring between controls and dimming panel(s), and the dimming panel(s). Provide one diagram per each dimming panel location. Block diagrams involving cross-referencing to catalog spec/app sheets will not be acceptable.

6. Detailed factory and field-test procedures.

7. Manufacturer's certifications and warranties.

8. Operation and Maintenance Manuals

9. Including all customized submittal data above, warranties, troubleshooting guides, spare parts list, name and telephone number of local authorized service representative.

F. Submittals shall be clearly marked to demonstrate compliance with all requirements of the Contract Documents. Any deviations from Contract requirements shall be prominently identified and explained.

G. Submittals shall clearly differentiate between factory and field installed work.

H. Manufacturer shall have their quality system registered to the ISO 9001 Quality Standard, including in-house engineering for all product design activities. Due to the exclusion of the Design Control element, ISO 9002 Registration is not acceptable.

I. Lighting control system shall meet IEC801-2, tested to withstand a l5kV electrostatic discharge without damage or loss of memory.

J. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

1.6 COORDINATION

A. Coordinate features of devices specified in this Section with systems and components specified in other Sections to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and equipment in Manufacturer's original, unopened protective packaging.

B. Store materials in a clean, dry place and protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Handle materials carefully to prevent damage to finished surfaces. Maintain protective coverings until installation is complete and remove as part of final cleanup. Touch up damaged finishes to match the original finish.

1.8 WARRANTY

A. Retain this Article if a special warranty is required for dimming control equipment.

1.9 GENERAL WARRANTY

A. Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

1.10 SPECIAL WARRANTY

A. Written warranty, executed by Manufacturer agreeing to repair or replace components of dimming controls that fail in materials or workmanship within specified warranty period.

B. Manufacturer shall provide a full 2 year warranty on all equipment supplied inclusive of commissioning by a factory-employed engineer. Warranty shall cover 100 percent of the cost to repair or replace any parts required over the first 2 years, which are directly attributable to the Manufacturer.

1.11 COMMISSIONING

A. The Contractor shall provide the Manufacturer and Engineer with 10 working days notice of the scheduled commissioning date.

B. Upon completion of the installation, the system shall be completely commissioned by a factory-employed engineer. The check-out will be performed after all loads have been tested live for continuity and freedom from defects and that all control wiring has been connected and checked for proper continuity. The factory-employed engineer shall demonstrate and educate the Owner's representative(s) on the system capabilities, operation, and maintenance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the requirements of the Contract Documents, provide products by one of the following Manufacturer(s):

1. Lutron Electronics Co., Inc.
   a. Multizone relay-based room controllers: QSN-4T16-S(0-10V).
   b. Modular dimming control systems: GrafikEye 4000 series, GP dimming panels.
   c. Network/lighting control panels:
      1) Quantum light management hub(s) QP2/QP3
      2) XP/LP switching/dimming panels
   d. Wallstation controls: seeTouch QS keypads.
   e. All other modules/interfaces required for a complete and operable system
   f. Software: Qadmin.

2. Acuity Brands (LC&D)

3. Cooper Controls (Eaton)

4. Pre-approved equal.

B. Manufacturers' component numbers utilized in this specification are based on the products of Lutron Electronics Co., Inc. and are intended to establish standards of quality and performance characteristics only.

2.2 MATERIALS

A. Dimming Cabinets:

1. Cabinets shall be wall mounted NEMA-1 grade, constructed of sheet steel plates not less than Number 14 U.S. gauge. Contractor shall reinforce wall as required for wall-mounted panels.

2. Panel shall be completely pre-assembled and factory tested by the Manufacturer. The Contractor shall be required to provide input feed wiring, load wiring, and control wiring. No other wiring or assembly by the Contractor shall be permitted. All input feed, load, and control terminals shall be front accessible without the need to remove dimmer assemblies or other components.

3. Cabinets shall contain input and output circuit breakers to provide primary line side protection and outgoing branch circuit protection for each dimming module. Circuit breakers shall be designed to trip within 9 msec after a 400A surge. Circuit breakers shall contain a visual trip indicator and shall be rated at 10,000 AIC (120V) or 14,000 AIC (277V).

4. Cabinets shall contain current carrying terminals with factory-installed brass or copper jumpers. These jumpers will enable power to completely bypass the dimmer modules for temporary power during installation and any future service work. Bypass jumpers shall be clearly and permanently labeled and shall be re-usable at any time. Low voltage control signal methods of bypass shall not be acceptable. Alternatively, the Contractor may provide a switch panel with a specification grade SPST switch wired in parallel with each dimming module. Provide one switch per module with a capacity equal to the input breaker rating of the dimmer module. Engrave each switch faceplate with the dimming module number, NORMAL in the switch open position, and BYPASS in the switch closed position. Provide details of this switching panel with the dimming system submittals.

5. Cabinets shall be cooled exclusively by means of free convection, unaided by fans, in an ambient temperature range of 0 degrees C (32 degrees Fahrenheit) to 40 degrees Celsius (104 degrees Fahrenheit). To provide the utmost in reliability, cabinets that normally use cooling fans must have their capacity de-rated accordingly and as such may require either larger panels or a greater number of panels than shown on the drawings. Any additional labor and material costs required as a result of the need for additional panels shall be included in the Electrical Contractor’s bid.

6. Panels shall be passively cooled via free-convection, unaided by fans. Fan-dependent or fan-assisted systems, or those that recommend regularly scheduled maintenance for air filtration components are not acceptable.

7. Panels requiring the neutral feeder to be sized larger than any individual phase feeder shall not be acceptable.

8. Activation of a circuit protection device shall affect only the single dimmer it is wired to protect.

9. Panel shall provide capability to electronically assign each circuit to any zone in the dimming system. Panels using mechanical switches, rewiring, or EPROMS shall not be acceptable. All circuits shall be capable of being operated (dimmed or switched where appropriate) from the panel.

10. Where indicated on the drawings, dimming and switching panel(s) shall be capable of operating under 2 optically isolated control systems. Panel shall be capable of auto-detecting between Manufacturer's control protocol and DMX512 protocol for each control system. Panel response to control changes shall take no more than 25 milliseconds. Panel shall be capable of assigning each dimmer to either control system on a circuit-by-circuit basis. Panel shall also be capable of conditionally changing assignment from one system to the other.

B. Dimming Modules:

1. Silicon thyristors shall be used to control the power furnished to the loads. The complete load current shall be carried by these devices. They shall be capable of withstanding surges, without impairment to performance, of 6000V/3000A as specified in IEEE std. 587-1980. In addition, under fully loaded operating conditions, all devices shall operate at a minimum 20 degrees Celsius safety margin below the component temperature rating.

2. A positive air gap relay shall be employed with each dimmer to ensure that the load circuits are open when the “off” function is selected at a control station. Use of semi-conductors to accomplish this result shall not be acceptable. These relays need not be integral to the dimming module, but must be integral to the dimming cabinet. Dimming Manufacturer shall provide and warrant both the relays and the necessary control interface(s) as part of the dimming system.

C. System Power-Failure Memory Feature:

1. Retain programming for a minimum of 90 days after power failure. When power is restored, return intensities of dimmed lights for each scene to levels set before failure.

2. Each dimmer shall incorporate an electronic "soft-start" default at initial turn-on that smoothly ramps the lights up to the appropriate levels within 0.5 seconds.

3. All dimming modules shall be voltage regulated so that plus or minus 10 percent change in line voltage shall cause no more than plus or minus 3 percent change in output voltage.

4. All dimming modules shall provide a smooth and continuous Square Law dimming curve throughout the entire dimming range.

5. All dimmers designed for use with inductive loads shall include the following additional features:

6. The maximum allowable asymmetry in the load waveform shall be plus or minus 1 VDC.

7. The dimmer shall incorporate circuitry to prevent the lights from momentarily “flashing” when the dimmer is turned on or off.

8. Quantities and sizes of each dimming module shall be provided to control each type of load shown on the load schedule and/or the drawings.

D. Low Voltage – Electronic Transformer:

1. Dimming performance shall not adversely affect sound rating of electronic transformers. In addition, no flicker or interaction shall occur at any point in the dimming range.

2. Modules shall provide a dimming range from 100-0 percent (blackout). Minimum light levels shall be user adjustable in order to compensate for different loading of each dimmer module.

E. Fluorescent (Hi-Lume) Solid-State Dimming Ballast

1. Fluorescent modules shall be rated to control 430 MA rapid start (3 feet, 4 feet), 800 MA high output (3 feet, 4 feet, 8 feet), or 265 MA T-8 (3-, 4-, 5-foot) lamps at 120V or 277V AC. All lamps on the same circuit must have the same current rating (i.e. 800 MA), but may be different lengths. Ballasts for fluorescent fixtures required to be dimmed must be Lutron Hi-Lume “OSPCU” series. See fixture schedule in specification section 16510. The dimming performance shall be as follows:

2. Dimming range from 100-1 percent light output.

3. 1- and 2-lamp ballasts shall track evenly, with no perceptible difference in light levels for the same type lamps.

4. Different lamp lengths on the same circuit track evenly, with no perceptible difference in light levels for the same type lamps.

5. Ballasts shall be inaudible with no apparent humming or buzzing at any point in the dimming range.

6. No electrical noise shall be generated which could interfere with any other properly installed electrical equipment.

7. Minimum light levels shall be user-adjustable in order to compensate for different loading of each dimmer module. A zero percent control input from any control station shall turn the respective dimmer "off" completely.

F. Non-Dim Relay-Switched Loads:

1. The non-dim relay module shall be rated to switch either tungsten or inductive loads. Relays shall be of the positive air-gap type, and shall be rated to carry at least twice the actual connected load.

2. When used with a preset control system, the modules shall turn off and on positively at the start of the light level transition period.

G. Dimming Control Stations:

1. Control shall be low voltage type as specified here and as listed below and/or shown on the drawings. Controls shall use low voltage Class II wiring, electrically isolated from power wiring by means of a UL listed Class II transformer. A separate set of terminals shall be provided for each control station termination at the dimming panel and/or interface panels.

2. Faceplates shall be machined from a single piece of 1/8 inch thick metal base (minimum). Painted controls shall be painted by Manufacturer to exactly match Architect's sample.

3. Faceplates shall attach to the wall box using no visible means of attachment. To prevent unauthorized faceplate removal, setscrews through the faceplate edge shall securely hold the faceplate to the switchbox. Alternately, control shall be mounted in an enclosure with a locking translucent cover. Paint enclosure per Architect's sample.

4. Controls shall be engraved with appropriate zone and/or scene descriptions, furnished to the Manufacturer prior to fabrication. Size and style of engraving type shall be determined by the Architect. Any silk-screened borders, logos, graduations, etc. shall use a graphic process that chemically bonds the graphics to the metal faceplate, resisting removal by scratching, cleaning, etc.

5. All control stations shall provide power-failure memory. Should power be interrupted to the control station and subsequently returned, the lights will come back on to the same levels set prior to the power interruption. Restoration to some other default level is not acceptable, unless specifically noted elsewhere.

H. Scene based (GrafikEye) Control Systems

1. Each flush-mount unit shall consist of four touch-buttons to provide scene selection, LEDs to indicate lighting levels of each zone, and electronic face between each scene. Fade rate for all zones shall be adjusted from 0 to 60 seconds by one adjustment at the control. The fifth touch-button shall switch off the system. The entire present section shall be concealed behind a smoked translucent flush-mounted window, which shall appear black except for the illuminated potentiometers in the active scene. Unit shall be capable of add-on interface to external equipment, providing electrical isolation, without modification of the back box unit, or mounting of an addition panel.

2. Provide remote preset activator control containing only the same four-scene activating buttons with LEDs and “off” button as specified above, as shown on the drawings.

3. RS232 interface: Provide required modules for interface to A/V system.

I. Controls:

1. Definitions:
   a. A "scene" or "preset" is a specific look or mood created by different lighting zones set at different intensities. A "zone" is one or more lighting circuits, which are controlled together as a group.

2. Control shall provide power failure memory. Should power be interrupted and subsequently returned, the lights will come back on to the same levels set prior to the power interruption without requiring any actions on the part of the user. Restoration to some other default level is not acceptable, unless specifically noted elsewhere.

3. Wiring from dimming and switching panel(s) to preset control unit(s) and wall stations shall be low voltage type Class 2 wiring.

4. Faceplate shall attach using no visible means of attachment.

5. Controls shall be engraved with appropriate zone and/or scene descriptions, furnished to the Manufacturer prior to fabrication. Size and style of engraving type shall be determined by the Architect. Any silk-screened borders, logos, graduations, etc., shall use a graphic process that chemically bonds the graphics to the metal faceplate, resisting removal by scratching, cleaning, etc.

6. Manufacturer shall ensure the following items regarding product color:
   a. Product color matches NEMA standard WDI, Section 2, and the maximum color deviation from this standard shall not exceed Δ E=1, CIE L*a*b color space units. For non-NEMA colors, color match coordination shall be provided on request.
   b. Color variation of any control in the same product family shall not exceed Δ E=1, CIE L*a*b color units.
   c. Visible parts shall exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674-89. Manufacturer to submit proof of testing upon request.

7. Controls shall provide an immediate, local LED response upon button activation to indicate that a system command action has been requested. LED will remain lit contingent upon receiving system confirmation of the successful completion of the command.

J. Preset Control Stations:

1. Control shall mount individually in standard 2-, 3-, or 4-gang U.S. wall boxes.

2. Control shall provide 4 preset lighting scenes and “off” for up to 24 control zones. Control shall be capable of storing an additional 12 preset lighting scenes, which can be accessed via wall stations and/or control interfaces. Up to 64 zones may be tied together in one system. Preset shall be set via easy-to-use raise/lower switches, one raise and lower switch per zone. The intensity for each zone shall be indicated via an illuminated bar graph, one bar graph per zone. More than one zone may be proportionately raised or lowered at the same time. Programming of preset scenes shall be accomplished without the use of an 'enter' or 'store' button. Additionally, one or more zones may be temporarily overridden without altering the scene values that are stored in memory.

3. Lighting levels shall fade smoothly between scenes at time intervals of 0-59 seconds or 1-60 minutes. The fade time shall be separately selectable for each scene and shall be indicated by a digital display for the current scene. Pressing a scene select button will illuminate the corresponding scene LED and simultaneously begin changing the bar graph levels to reflect the currently selected scene. In the event that a preset scene with a fade time greater than 5 seconds is initially selected from an “off” condition, the programmed fade time shall be temporarily overridden, unless otherwise noted, and the lights shall fade up to that scene over a 5-second time span.

4. Control shall provide tamperproof protection of scenes using a minimum of 4 levels of electronic “lockout” which prevent alterations of scene values stored in memory. Highest level of “lockout” shall be capable of disabling manual control at the preset control unit.

5. Where indicated, control shall be capable of complete setup of all parameters locally, or when used with the appropriate programmer interface, via an IBM-compatible PC. Parameters shall include scenes (including both light levels in 1 percent increments and fade times), load types, low-end trim, tamperproof protection of scenes, and communication between control units (if applicable). Permanent installation of the PC shall not be required unless indicated on the drawings.

6. Scene Selection Control(s):

7. Four Scene Selection Control(s):
   a. Control shall be capable of recalling preset light levels for four scenes, each providing green LED status feedback. Control shall be capable of recalling one of four different banks of scenes, which can be configured in the field through DIP switches.

K. Multi-zone lighting control/dimming panels.

1. Provide lighting control modules as indicated or as required to control the loads as indicated.

2. General Requirements.
   a. Listed to UL 508 as industrial control equipment.
   b. Delivered and installed as a listed factory-assembled panel.
   c. Passively cooled via free-convection, unaided by fans or other means.
   d. Mounting: Surface.
   e. Connection without interface to wired:
      1) Occupancy sensors.
      2) Daylight sensors
   f. LED status indicators confirm communication with occupancy sensors, daylight sensors, and IR receivers.
   g. Contact Closure Input
      1) Directly accept contact closure input from a dry contact closure or sold-state output without interface to:
      2) Activate scenes.
         a) Scene activation from momentary or maintained closure.
      3) Enable or disable after hours.
         a) Automatic sweep to user-specified level after user-specified time has elapsed.
         b) System will provide occupants a visual warning prior to sweeping lights to user-specified level
         c) Occupant can reset timeout by interacting with the lighting system.
      4) Activate or deactivate demand response (load shed).
         a) Load shed event will reduce lighting load by user-specified amount.
   h. Emergency Contact Closure Input:
      1) Turn all zones to full output during emergency state via direct contact closure input from UL 924 listed emergency lighting interface, security.
   i. Supplies power for control link for keypads and control interfaces.
   j. Distributes sensor data among multiple lighting control modules.
   k. Capable of being controlled via wireless sensors and controls.

3. 0-10V Lighting Control Modules.
   a. Coordination Between Low Voltage Dimming Module and Line Voltage Relay: Capable of being electronically linked to single zone.
   b. Single low voltage dimming module; capable of controlling following light sources
      1) 0-10V analog voltage signal.
         a) Provide Class 2 isolated 0-10 V output signal conforming to IEC 60929.
         b) Sink current per IEC 60929.
   c. Switching:
      1) Rated Life of Relay: Typical of 1,000,000 cycles at fully rated 16 A for all lighting loads.
      2) Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
      3) Fully rated output continuous duty for inductive, capacitive, and resistive loads.
      4) Module to integrate up to four individually controlled zone
      5) Utilize air gap off, activated when user selects "off" at any control to disconnect the load from line supply.

L. Wallstations

1. Provide control stations with configuration as indicated or as required to control the loads as indicated.

2. Wired Control Stations:
   a. General Requirements:
      1) Power: Class 2 (low voltage).
      2) UL listed.
      3) Provide faceplates with concealed mounting hardware. Borders, logos, and graduations to use laser engraving or silk-screened graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.

3. Multi-Scene Wired Control:
   a. General Requirements:
      1) Communications: Utilize RS485 wiring for low-voltage communication.
      2) Engrave keypads with button, zone, and scene descriptions. Provide sample engraving in shop drawing submission.

4. Software Configuration:
   a. Customizable control station device button functionality:
      1) Buttons can be programmed to perform single defined action.
      2) Buttons can be programmed to perform defined action on press and defined action on release.
      3) Buttons can be programmed using conditional logic off of a state variable such as time of day or partition status.
      4) Buttons can be programmed to perform automatic sequence of defined actions.
      5) Capable of deactivating select keypads to prevent accidental changes to light levels.
      6) Buttons can be programmed for raise/lower of defined loads.
      7) Buttons can be programmed to toggle defined set of loads on/off.

5. Status LEDs:
   a. Upon button press, LEDs to immediately illuminate.
   b. LEDs to reflect the true system status. LEDs to remain illuminated if the button press was properly processed or LEDs to turn off if the button press was not processed.
   c. Support logic that defines when LED is illuminated:
      1) Scene logic (logic is true when all zones are at defined levels).
      2) Room logic (logic is true when at least one zone is on).
      3) Pathway logic (logic is true when at least one zone is on).
      4) Last scene (logic is true when spaces are in defined scenes).

M. LIGHTING CONTROL PANELS

1. Relay Performance Requirements
   a. A component operated at 10°C above the rated temperature will have 1/2 the life expectancy. A component operated at 20°C above the rated temperature will have 1/4 the life expectancy.

b. Electrolytic capacitors to operate at least 20°C below the component manufacturer's maximum temperature rating when device is under fully-loaded conditions in 40°C (104°F) ambient temperature.
c. Capable of withstanding repetitive inrush current of 50 times operating current without impacting lifetime of dimmer/relay.
d. Design and test relays to withstand line-side surges without impairment to performance.

1) Panels: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 3,000 amps per ANSI/IEEE C62.41B.

e. Utilize air gap off, activated when user selects “off” at any control to disconnect the load from line supply.
f. Possess power failure memory such that if power is interrupted and subsequently returned, lights will automatically return to same levels (on or off) prior to power interruption within 3 seconds.
g. Non-dim circuits to meet the following requirements:

1) Rated life of relay: Minimum 1,000,000 cycles.
2) Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
3) Fully rated output continuous duty for inductive, capacitive and resistive loads.

h. UL Listed 30 Amp, Latching, 18,000 SCCR, 277VAC Ballast and HID and 20 Amp Tungsten at 120 Vac.
i. Relays shall be individually replaceable. Relay terminal blocks shall be capable of accepting 2 #8AWG wires on both the line and the load side. Systems that do not allow for individual relay replacement or additions are not acceptable.
j. Relays to be rated for 250,000 operations minimum at a full 30a lighting load, default to closed at normal power loss, Normally Closed Latching (NCL). All incandescent circuits shall be energized by use of a Normally Closed SoftStart™ (NCSS) relay rated at 100,000 operations at full 20a load. No exceptions.
k. Optional relay types available shall include: Normally Open Latching (NOL) relay rated for 250,000 operations, a 600v 2-pole NO and NC and a Single Pole, Double Throw (SPDT) relay.
l. A component operated at 10°C above the rated temperature will have 1/2 the life expectancy. A component operated at 20°C above the rated temperature will have 1/4 the life expectancy.

2. Electrolytic capacitors to operate at least 20°C below the component manufacturer's maximum temperature rating when device is under fully-loaded conditions in 40°C (104°F) ambient temperature.

3. Load Handling Thyristors (SCRs and triacs), Field Effect Transistors (FETs), and Isolated Gate Bipolar Transistors (IGBTs): The component’s maximum current rating to be at least 2 times the dimmer’s/relay’s rated operating current.

4. Capable of withstanding repetitive inrush current of 50 times operating current without impacting lifetime of dimmer/relay.

5. Design and test dimmers/relays to withstand line-side surges without impairment to performance.
   a. Panels: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 3,000 amps per ANSI/IEEE C62.41 and per IEC 61000-4-5 surge requirements.
   b. Other power handling devices: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 200 amps per ANSI/IEEE C62.41.

6. Utilize air gap off to disconnect the load from line supply.

7. Designed and tested to withstand discharges without impairment of performance when subjected to discharges of 15,000 volts per IEC 801-2.

8. Mechanical:
   a. Listed to UL 508 (United States) as industrial control equipment, approved as applicable.
   b. Delivered and installed as a UL listed factory assembled panel.
   c. Field wiring accessible from front of panel without need to remove dimmer assemblies or other components.
   d. Panels passively cooled via free-convection, unaided by fans or other means.
   e. Ship panels with each dimmer in mechanical bypass position by means of jumper bar inserted between input and load terminals. Jumpers to carry full rated load current and be reusable at any time. Mechanical bypass device to allow for switching operation of connected load with dimmer removed by means of circuit breaker.
   f. NEMA 1 rated enclosure with hinged door.
   g. 16 AWG steel barrier shall separate the high voltage and low voltage compartments of the panel and separate 120v and 277v.
   h. LCP input power shall be capable of accepting 120v or 277v without rewiring

9. LCD Panel Processor
   a. System to be password protected.
   b. Language selection: English.
   c. Integral contact closure inputs.
   d. Programming and system operation:

      1) Control stations, control interfaces and contact closure inputs

         a) Assign functionality of each control station button.

         b) Select patterns.

         c) Select customized pattern.
         d) Enable/Disable time clock.
         e) Initiate delay to off.
         f) Toggle one, some or all zones

      2) RS232 interface or Ethernet interface.
      3) Contact closure output: Momentary or maintained.

e. Time clock

1) Integral astronomical time clock

a) Geographic location (city or latitude/longitude).
b) Adjustable date and time format.
c) Adjustable starting and ending of daylight savings time.
d) Review and modify time clock schedule to add, copy, modify and delete events.

f. Overrides:

1) Set circuit status.
2) Select pattern.
3) Time clock override.
4) Control station overrides.
5) After-hours override.

10. Diagnostics and Service:
    a. Replacing relay does not require re-programming of system or processor.
    b. Relays: Include diagnostic LED's to verify proper operation and assist in system troubleshooting.
    c. Relay panels: Include tiered control scheme for dealing with component failure that minimizes loss of control for occupant.

        1) If lighting control system fails, lights to remain at current level. Panel processor provides local control of lights until system is repaired.
        2) If panel processor fails, lights to remain at current level. Circuit breakers can be used to turn lights off or to full light output, allowing non-dim control of lights until panel processor is repaired.
        3) If relay fails, factory-installed mechanical bypass jumpers to allow each relay to be mechanically bypassed. Mechanical bypass device to allow for switching operation of connected load with relay removed by means of circuit breaker.

11. LCP Manufacturers:
    a. Lutron
    b. Acuity - LC&D
    c. Cooper Controls

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Equipment shall be installed utilizing Manufacturer's catalogue cut sheets and installation instructions and in accordance with these specifications.

B. Contractor shall furnish all equipment, labor, system setup, and other services necessary for the proper installation of the products/system as indicated on the drawings and specified herein. System setup shall include defining each dimmer's load type, assigning each load to a zone, and setting the control functions.

C. Install equipment level and plumb and according to Manufacturer's written instructions.

D. Mount control equipment according to Manufacturer's written instructions and requirements in Division 16 Section "Basic Electrical Materials and Methods."

E. Mounting heights indicated are to bottom of unit for suspended items and to center of unit for wall-mounting items.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring as specified in Division 26 Section "Building Wire and Cable" for low-voltage connections.

B. Wiring Method:

1. Install all wiring in raceway as specified in Division 26 Section "Conduit" and “Boxes”.

C. Bundle, train, and support wiring in enclosures.

D. Ground equipment.

E. Connections:

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.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "General Requirements for Electrical Work."

B. Identify components and power and control wiring according to Division 26 Section "Electrical Identification."

C. Label each system control module and each remote dimmer bank with a unique designation. Make designations on elevated components readable from floor.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Engage a factory-authorized service representative to test, adjust, and program dimming controls.

B. Schedule visual and mechanical inspections and electrical tests with at least ten business days' advance notice to the Manufacturer and Engineer.

C. The Manufacturer shall inspect control components for defects and physical damage, testing laboratory labeling, and nameplate compliance with the Contract Documents.

D. The Contractor or Manufacturer shall check tightness of electrical connections with torque wrench calibrated within previous six months. Use the Manufacturer's recommended torque values.

E. The Contractor or Manufacturer shall verify settings of photoelectric devices with photometer calibrated within previous six months.

F. Electrical Tests:

1. Use particular caution when testing devices containing solid-state components. Perform the following according to Manufacturer's written instructions:
   a. Continuity tests of circuits.

2. Operational Tests:
   a. Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
   b. Include testing of dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

G. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

H. Test Labeling:

1. After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

I. Reports:

1. Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.6 CLEANING

A. Cleaning:

1. Clean equipment and devices internally and externally using methods and materials recommended by Manufacturers, and repair damaged finishes.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of for training. Use both classroom training and hands-on exercises.

2. Training Aid:

Use the approved final version of maintenance manuals as a training aid.

3. Schedule training with Owner, through Architect, with at least 14 days' advance notice.

4. Video Training:
   a. Provide 2 DVD optical storage media copies of an instructional videotape covering features, capabilities, operation, and maintenance of installed lighting control system. Illustrate actual equipment and related functions. Show cause-and-effect sequences during operation. Cross-reference instruction manuals throughout. Follow same order of presentations as instruction manual.

3.8 ON-SITE ASSISTANCE

A. Occupancy Adjustments:

1. Within 1 year of date of Substantial Completion, provide up to 3 project site visits, when requested, to adjust light levels, make preset scene changes, and adjust controls to suit actual conditions.

B. Manufacturer shall provide toll-free technical support hotline 24 hours per day, 7 days per week.

C. Manufacturer shall be capable of providing on-site service support within 24 hours anywhere in the continental U.S.A.

D. Manufacturer shall offer a renewable Service Contract on a year-to-year basis that will include parts and factory labor as well as annual training visits.

END OF SECTION 26 09 33

SECTION 26 09 34 - LIGHTING CONTROL 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. This Section includes the following:

1. Factory assembled switching panels.

2. Low voltage wall stations and control interfaces.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

3. Section 26 05 00 – General Requirements for Electrical Work.

C. System Description

1. Furnish and install a complete system for the control of lighting and other equipment as indicated on the plans, detailed in the manufacturer submittal and as further defined herein. Contractor is solely responsible to verify quantity, installation locations and wiring requirements for this project. Specific manufacturers catalog numbers, when listed in this section are for reference only. It is the responsibility of the contractor to verify with the lighting control manufacturer all catalog information and specific product acceptability.

2. The system shall include but not be limited by the following list: Pre-wired, microprocessor controlled relay panels with electrically held, electronically latched relay panels controlled via a complete list of communication based accessories including digital switches, Digital Time Clock (DTC), and other devices. The type of lighting control equipment and wiring specified in this section is covered by the description: Microprocessor Controlled Digital Relay Lighting Control system with RS 485 Bus communications. Requirements are indicated elsewhere in these specifications for work including, but not limited to, raceways and electrical boxes and fittings required for installation of control equipment and wiring. They are not the work of this section.

3. The lighting control system is a networked system that communicates via RS485. The system must be able to communicate with fully digital centralized relay panels, digital switches, various interfaces and shall include all operational software. Lighting control system shall include all hardware and software. Software to be resident within the lighting control system. System shall provide local access to all programming functions at the master LCP and remote access to all programming functions via dial up modem and through any standard computer workstation running an industry standard internet browser. Lighting control system shall have server built into the master LCP that "serves" HTML pages to any authorize workstation. Desktop computers are not part of this section and will be provided by others. Non-networked, non-digital, non-server capable systems not acceptable.

4. System software shall provide real time status of each relay, each zone and each group.

5. Lighting control system shall be able to be monitored by and take commands from a remote PC. At any time, should the remote PC go off-line all system programming uploaded to the lighting control system shall continue to operate as intended. Systems requiring an on line PC or server for normal operation are not acceptable

6. All devices shall be pre-addressed at the factory. Field addressing is not acceptable.

7. All programs, schedules, time of day, etc, shall be held in non-volatile memory for a minimum of 10 years at power failure. At restoration of power, lighting control system shall implement programs required by current time and date.

8. System shall be capable of flashing lights Off/On any relay or any zone prior to the lights being turned Off. The warning interval time between the flash and the final lights off signal shall be definable for each zone. Occupant shall be able to override any scheduled Off sweep using local wall switches within the occupied space. Occupant override time shall be locally and remotely programmable and not exceed 2-hours.

9. The system shall be capable of implementing On commands, Off commands for any relay, group or zone by means of digital wall switches, specification grade line voltage type wall switches, photocell, web based software or other devices connected to programmable inputs in a lighting control panel.

10. The lighting control system shall provide the ability to control each relay and each relay group per this specifications requirement. All programming and scheduling shall be able to be done locally at the master LCP and remotely via dial up modem and via the Internet. Remote connection to the lighting control system shall provide real time control and real time feedback.

1.3 SUBMITTALS

A. Submit under provisions of Section 26 05 00.

B. Shop Drawings

1. Provide a schematic (1-line diagram) of LCS.

2. Provide a complete bill of materials.

3. Provide catalog cut sheets with performance specifications demonstrating compliance with specified requirements.

4. Provide keypad color, style, and engraving for all unique keypads.

C. Operation and Maintenance Manual (3 Copies)

1. Provide a complete as-built schematic (1-line diagram) of the LCS.

2. Provide a complete as-built keypad schedule.

3. Provide DVD of training sessions.

4. Provide copies of all approved shop drawings.

5. Provide warranty and maintenance information including contact info (front cover).

D. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

1.4 QUALITY ASSURANCE / QUALIFICATIONS

A. Manufacturer: Minimum 10 years experience in manufacture of architectural lighting controls.

B. Architectural Lighting Control System:

1. Listed by UL specifically for the required loads. Provide evidence of compliance upon request.

1.5 PROJECT CONDITIONS

A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:

1. Ambient temperature: 0°C to 40°C (32°F to 104°F).

2. Relative humidity: Maximum 90%, non-condensing.

3. Lighting control system must be protected from dust during installation.

1.6 STANDARDS

A. This contractor shall comply with all state and local codes having jurisdiction.

B. Underwriters Laboratories, Inc. (UL)

1. 916 – Lighting Control Panels

2. 924 - Emergency Lighting and Power Equipment

C. National Electrical Code

1. Article 725

1.7 WARRANTY

A. Provide manufacturer's five (5) year parts warranty.

1.8 MAINTENANCE

A. Make ordering of new equipment for expansions, replacements and spare parts available to end user.

B. Make new replacement parts available for minimum of 10 years from date of manufacture.

C. Provide factory direct technical support hotline 24 hours per day, 7 days per week.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of design product: LC&D GR1400 "Blue Box Classic" (minimum 16 contactors each) or subject to compliance and prior approval with specified requirements of this section, 1 of the following:

1. Lutron Softswitch128.

2. Wattstopper Peanut Panel.

B. Substitutions: Under provisions of Division 01.

1. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.

2. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring. The contractor shall provide complete engineered shop drawings (including power wiring) with deviations from the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.2 GENERAL

A. Provide hardware that is designed, tested, manufactured and warranted by a single manufacturer.

2.3 RELAY PERFORMANCE REQUIREMENTS

A. UL Listed 30 Amp, Latching, 18,000 SCCR, 277VAC Ballast and HID and 20 Amp Tungsten at 120 Vac.

B. Relays shall be individually replaceable. Relay terminal blocks shall be capable of accepting 2 #8AWG wires on both the line and the load side. Systems that do not allow for individual relay replacement or additions are not acceptable.

C. Relays to be rated for 250,000 operations minimum at a full 30a lighting load, default to closed at normal power loss, Normally Closed Latching (NCL). All incandescent circuits shall be energized by use of a Normally Closed SoftStart™ (NCSS) relay rated at 100,000 operations at full 20a load. No exceptions.

D. Optional relay types available shall include: Normally Open Latching (NOL) relay rated for 250,000 operations, a 600v 2-pole NO and NC and a Single Pole, Double Throw (SPDT) relay.

E. A component operated at 10°C above the rated temperature will have 1/2 the life expectancy. A component operated at 20°C above the rated temperature will have 1/4 the life expectancy.

2.4 RELAY PANELS

A. NEMA 1 rated enclosure with hinged door.

B. 16 AWG steel barrier shall separate the high voltage and low voltage compartments of the panel and separate 120v and 277v.

C. LCP input power shall be capable of accepting 120v or 277v without rewiring

D. Control electronics in the low voltage section shall be capable of driving 2 to 48, 30a, 18,000 SCCR rated latching relays, control any individual or group of relays, provide individual relay overrides, provide a master override for each panel, store all programming in non-volatile memory, after power is restored return system to current state, provide programmable blink warn timers for each relay and every zone, and be able to control relays that default to Open, Normally Open Latching (NOL) or relays that default to Closed, Normally Closed Latching (NCL).

E. Lighting control system shall be digital and consist of a Master LCP, Slave LCPs, and digital switches. All system components shall connect and be controlled via a single Category 5, 4 twisted pair cable with RJ45 connectors, providing real time two-way communication with each system component. Analog systems are not acceptable.

F. The lighting control system is a networked system that communicates via RS485 and includes centralized relay panels, micro relay panels, digital switches, photocells, various interfaces and operational software. The intent of the specification is to integrate all lighting control into one system. Lighting control system shall include all hardware and software. Software to be resident within the lighting control system. System shall provide local access to all programming functions at the DTC and remote access to all programming functions via dial up modem and through any standard computer workstation running an industry standard internet browser. Lighting control system shall have server built into the master LCP that "serves" HTML pages to any authorized workstation. Desktop computers are not part of this section and will be provided by others. Non-networked, non-digital system not acceptable.

2.5 LOW VOLTAGE SWITCHES

A. All switches shall be digital and communicate via RS 485. Contact closure style switches. The programming for a digital switch will reside in the switch itself, via double EPROM memory. Any digital switch button function shall be able to be changed locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet.

B. Digital low voltage switch shall be a device that sits on the lighting control system bus. Digital switch shall connect to the system bus using the same cable and connection method required for relay panels. System shall provide capability to locally and remotely program each individual switch button, monitor and change function of each button locally and remotely. Each button shall be capable of being programmed for On only, Off only, On/Off (toggle), Raise (Dim up) and Lower (Dim down). Switches requiring low voltage control wires to be moved from one input terminal to another to accomplish these functions are not acceptable.

C. Keyed switches shall be programmable and connect to the lighting controls system bus.

D. Each touch pad is to be identified as to function by an engraved label. Switches must be capable of handling electrostatic discharges of at least 30,000 volts (1cmspark) without any interruption or failure in operation.

E. Keypad colors, styles, and engraving shall be verified by the Owner, Engineer, and Architect during shop drawings.

2.6 ASTRONOMICAL TIME CLOCK

A. A Digital Time Clock (DTC) shall control and program the entire lighting control system and supply all time functions and accept interface inputs.

B. DTC shall be capable of up to 32 schedules. Each schedule shall consist of one set of On and Off times per day for each day of the week and for each of two holiday lists. The schedules shall apply to any individual relay or group of relays.

C. The DTC shall be capable of controlling up to 126 digital devices on a single bus and capable of interfacing digitally with other individual busses using manufacturer supplied interface cards.

D. The DTC shall accept control locally using built in button prompts and use of a 8 line 21-letter display or from a computer or modem via an on-board RS 232 port. All commands shall be in plain English. Help pages shall display on the DTC screen.

E. The DTC shall be run from non-volatile memory so that all system programming and real time clock functions are maintained for a minimum of 15 years with loss of power.

F. Pre-installed Unity™ lighting control software shall provide via local or remote PC a visual representation of each device on the bus, show real time status and the ability to change the status of any individual device, relay or zone. System shall be capable of running optional Unity GX lighting control software, which shall provide for directly importing vector based graphics. No exceptions.

G. Pre-Installed modem that allows for remote programming from any location using a PC. Modem to include all necessary software for local or remote control.

H. DTC shall provide system wide timed overrides. Any relay, group or zone that is overridden On, before or after hours, shall automatically be swept Off by the DTC a maximum of two (2) hours later.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 EQUIPMENT INSTALLATION

A. Mount relay control cabinets adjacent to respective lighting panelboard. Cabinet shall be surface or flush mount, per plans. Wiring between relay control cabinet and panelboards to be per local codes and acceptable industry standards. Under no circumstances will any extra be authorized for payment to the EC or GC due to the EC’s lack of knowledge or understanding of any and all prevailing codes or specified manufacturer’s installation requirements. Neatly lace and rack wiring in cabinets. During construction process, protect all interior components of each relay

panel and each digital switch from dust and debris. Any damage done to electronic components due to non-protection shall be the sole responsibility of the installing contractor.

B. Switches: Provide outlet boxes, single or multi-gang, as shown on the plans for the low voltage digital switches. Mount switches as per plans. Supply faceplates per plans and specifications. EC is specifically responsible to supply and install the required low voltage cable, Category 5, 4 twisted pair, with RJ45 connectors and snagless boots (commonly referred to as Cat 5 patch cable) between all switches and panels. Field-test all Cat 5 patch cable with a recognized cable tester. All low voltage wire to be run in conduit, per local codes.

C. Wiring

1. Do not mix low voltage and high voltage conductors in the same conduit. No exceptions.

2. Ensure low voltage conduits or control wires do not run parallel to current carrying conduits.

3. Place manufacturer supplied “terminators” at each end of the system bus per manufacturers instructions.

4. Neatly lace and rack wiring in cabinets.

5. Plug in Category 5 patch cable that has been field-tested with a recognized cable tester, at the indicated RJ45 connector provided at each lighting control device, per manufacturers instructions.

6. Use Category 5 patch cable for all system low voltage connections. Additional conductors may be required to compensate for voltage drop with specific system designs. Contact LC&D or refer to the GR2400 manual for further information. Use shielded cable for dry contact inputs to lighting control system.

7. Do not exceed 4000ft-wire length for the system bus.

8. All items on the bus shall be connected in sequence (daisy chained). Star and spur topologies are not acceptable.

9. The specified lighting control system shall be installed by the electrical contractor who shall make all necessary wiring connections to external devices and equipment, to include photocell. EC to wire per manufacturer instructions.

3.3 INSTALLATION AND SET-UP

A. Verify that conduit for line voltage wires enters panel in line voltage areas and conduit for low-voltage control wires enters panel on low-voltage areas. Refer to manufacturer's plans and approved shop drawings for location of line and low-voltage areas. It is the responsibility of the contractor to verify with lighting control manufacturer all catalog information and specific product acceptability.

B. For approved line voltage type micro relay panel switches connected to matrixed inputs of the micro relay panel, furnish #18 AWG solid conductors. For all other digital switches provide wiring required by system manufacturer.

C. For classroom digital switches provide wiring required by system manufacturer

D. Contractor to test all low voltage cable for integrity and proper operation prior to turn over. Verify with system manufacturer all wiring and testing requirements.

E. Before Substantial Completion, arrange and provide a 1-day Owner instruction period to designated Owner personnel. Set-up, commissioning of the lighting control system, and Owner instruction includes:

F. Confirmation of entire system operation and communication to each device.

G. Confirmation of operation of individual relays, switches, occupancy sensors and daylight sensors

H. Confirmation of system Programming, photocell settings, override settings, etc.

I. Provide training to cover installation, maintenance, troubleshooting, programming, and repair and operation of the lighting control system.

J. Panels shall be located so that they are readily accessible and not exposed to physical damage.

K. Panel locations shall be furnished with sufficient working space around panels to comply with the National Electric Electrical Code.

L. Panels shall be securely fastened to the mounting surface by at least 4 points.

M. Unused openings in the cabinet shall be effectively closed.

N. Cabinets shall be grounded as specified in the National Electrical Code.

O. Lugs shall be suitable and listed for installation with the conductor being connected.

P. Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.

Q. Maintain the required bending radius of conductors inside cabinets.

R. Clean cabinets of foreign material such as cement, plaster and paint.

S. Distribute and arrange conductors neatly in the wiring gutters.

T. Follow the manufacturer's torque values to tighten lugs.

U. Before energizing the panelboard, the following steps shall be taken:

V. Retighten connections to the manufacturer's torque specifications. Verify that required connections have been furnished.

W. Remove shipping blocks from component devices and the panel interior.

X. Remove debris from panelboard interior.

Y. Follow manufacturers' instructions for installation and all low voltage wiring.

Z. Service and Operation Manuals:

AA. Submit operation and service manuals. Complete manuals shall be bound in flexible binders and data shall be typewritten or drafted.

BB. Manuals shall include instructions necessary for proper operation and servicing of system and shall include complete wiring circuit diagrams of system, wiring destination schedules for circuits and replacement part numbers. Manuals shall include as-built cable Project site plot plans and floor plans indicating cables, both underground and in each building with conduit, and as-built coding used on cables. Programming forms of systems shall be submitted with complete information.

CC. Comply with energy code lighting control system "Acceptance Requirements". Acceptance tests are used to verify that lighting controls were installed and calibrated correctly. These tests may require that a responsible party certify that controls are installed and calibrated properly. This is the installing contractor's responsibility. Verify requirements with building authority.

3.4 DOCUMENTATION

A. Each relay shall have an identification label indicating the originating branch circuit number and panelboard name as indicated on the drawings. Each line side branch circuit conductor shall have an identification tag indicating the branch circuit number.

B. Provide a point-to-point wiring diagram for the entire lighting control system. Diagram must indicate exact mounting location of each system device. This accurate "as built" shall indicate the loads controlled by each relay and the identification number for that relay, placement of switches and location of photocell. Original to be given to owner, copies placed inside the door of each LCP.

3.5 SERVICE AND SUPPORT

A. Start Up: EC shall contact LC&D at least 7 days before turnover of project. LC&D will remotely dial into the lighting control system, run diagnostics and confirm system programming. EC shall be available at the time of dial in to perform any corrections required by LC&D. EC is responsible for coordinating with GC and the owner the installation of a dedicated telephone line or a shared phone line with A/B switch. Phone jack to be mounted within 12" of Master LCP. Label jack with phone number. EC to connect phone line from jack to Master LCP.

B. Telephone factory support shall be available at no additional cost to the EC or Owner both during and after the warranty period. Factory to pre-program the lighting control system per plans and approved submittal, to the extent data is available. The specified manufacturer, at no added cost, shall provide additional remote programming via modem as required by the EC or Owner for the operation life of the system. Upon request manufacturer to provide remote dial up software at no added cost to system owner. No exceptions.

C. Provide a factory technician for on-site training of the owners' representatives and maintenance personnel. Coordinate timing with General Contractor. Provide ___ days of factory on-site training.

3.6 CLEANING

A. Division 1 - Execution Requirements: Final cleaning.

B. Clean photocell lens as recommended by manufacturer.

C. Clean all switch faceplates.

END OF SECTION 26 09 34

SECTION 26 22 00 - DRY-TYPE TRANSFORMERS

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. Dry type two winding transformers.

2. Dry type non-linear transformers.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTALS

A. Submit product data under provisions of Section 260500.

B. Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, KVA and impedance ratings and characteristics, tap configurations, insulation system type and rated temperature rise.

C. Test Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load and sound level.

D. Manufacturer’s Instructions: Indicate application conditions and limitations of use stipulated by project testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation and starting of product.

E. Manufacturer’s Certificate: Certify that Products meet or exceed specified requirements.

F. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation.

B. Comply with IEEE C57.12.91.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum five years documented experience.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by UL as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.1 TWO-WINDING TRANSFORMERS

A. Manufacturers:

1. Square D.

2. General Electric.

3. EATON/Cutler Hammer.

B. Description: NEMA ST 20, factory-assembled, air cooled dry type transformers, voltage and kVA ratings shall be as indicated on the drawings.

C. Transformer coils shall be of the continuous wound construction and shall be impregnated with nonhygroscopic thermosetting varnish.

D. Transformers 15kVA and larger shall be 150 degrees Celsius temperature rise above 40 degrees Celsius ambient, as indicated on the drawing. Transformers 15kVA and larger shall have a minimum of 4- 2 1/2 percent full capacity primary taps; 2 above and 2 below rated voltage.

E. Sound levels shall be warranted by the manufacturer not to exceed the following:

1. 15 to 50kVA A 45dB

2. 51 to 150kVA A 50dB

3. 151 to 300kVA A 55dB

F. Basic Impulse Level: 10kV for transformers less than 300kVA.

G. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

H. Mounting: Suitable for wall, floor, or trapeze mounting, except transformers larger than 75kVA, suitable for floor or trapeze mounting.

I. Coil Conductors: Continuous copper windings with terminations brazed or welded.

J. Enclosure: NEMA ST 20; as indicated on the drawings. Provide lifting eyes or brackets.

K. Isolate core and coil from enclosure using vibration-absorbing mounts.

L. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.2 NON-LINEAR TRANSFORMERS

A. Manufacturers:

1. Square D.

2. General Electric.

3. EATON/Cutler-Hammer

B. Description: NEMA ST 20, factory assembled, air cooled dry type non-linear transformers, voltage and kVA ratings as indicated on the drawings.

C. Transformer coils shall be of the continuous wound construction and shall be impregnated with nonhygroscopic thermosetting varnish.

D. Transformers 15kVA and larger shall be 150 degrees Celsius temperature rise above 40 degrees Celsius ambient. Transformers shall have a minimum of 4- 2 ½ percent full capacity primary tops; 2 above and 2 below rated voltage.

E. Basic Impulse Level: 10kV for transformers less than 300kVA.

F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

G. The transformer shall be designed to supply circuits with a harmonic profile equal to a k-factor rating of k-13. The minimum k-factor rating acceptable is k-13. K-factor rating shall comply with UL 1561 requirements.

H. Sound levels shall be warranted by the manufacturer not to exceed the following:

1. 15 to 50kVA A 45dB

2. 51 to 150kVA A 50dB

I. The neutral conductor shall be rated to carry 200 percent at normal phase current.

J. Mounting: Shall be as indicated on the drawings.

K. Coil Conductors: Continuous copper windings with terminations brazed or welded.

L. Enclosure: NEMA ST 20, Type 1, ventilated. Provide lifting eyes or brackets.

M. Isolate core and coil from enclosure using vibration-absorbing mounts.

N. Nameplate: Include transformer connection data.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Verify that surfaces are suitable for installing transformer supports.

B. Examine walls and floor for suitable mounting conditions when transformers will be installed.

3.3 PREPARATION

A. Provide concrete pad for each floor mounted.

3.4 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.

B. Set transformer plumb and level.

C. Use flexible conduit, under the provisions of Section 260533, 2 feet (0.6 Meters) minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

D. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

E. Provide seismic restraints.

F. Provide grounding and bonding in accordance with Section 260526.

3.5 FIELD QUALITY CONTROL

A. Check for damage and tight connections prior to energizing transformer.

B. Measure primary and secondary voltages and make appropriate tap adjustments.

1. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 5 percent. Submit recording and tap settings as test results.

2. Adjust buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent at secondary terminals.

3.6 DELIVERY, STORAGE and HANDLING

A. Deliver transformers individually wrapped for protection and mounted on shipping skids.

B. Accept transformers on site. Inspect for damage.

C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris and traffic.

D. Handle in accordance with manufacturer’s written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure and finish.

E. Temporary Heating: Apply temporary heat according to manufacturer’s written instruction within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

END OF SECTION 26 22 00

SECTION 26 24 13 - DISTRIBUTION SWITCHBOARDS

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. Main switchboard.

2. Distribution switchboard.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTALS

A. Submit under provisions of Section 260500.

B. Shop Drawings: Indicate front and side enclosure elevations with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of horizontal bus bars per phase, neutral, and ground; one-line diagrams; equipment schedule; switchboard instrument details; and utility company approval of metering compartment.

C. Product Data: Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.

D. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

1.4 QUALIFICATIONS

A. To be considered for approval, a manufacturer shall have specialized in the manufacturing and assembly of switchboards for at least 50 years.

B. Furnish products listed by Underwriters Laboratories Incorporated and in accordance with standards listed in Article 1.03 - References.

C. The manufacturing facility shall be registered by Underwriters Laboratories Incorporated to the International Organization for Standardization ISO 9002 Series Standards for quality.

1.5 WARRANTY

A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for the lesser of one year from date of installation or 18 months from the date of purchase.

1.6 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction, including conduit, piping, equipment and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D.

B. General Electric.

C. EATON/Cutler Hammer

2.2 SWITCHBOARD-GENERAL

A. Short Circuit Current Rating: Ratings shall be as indicated on the Drawings. The available ampere interrupting capacity indicated on the Drawings shall also be establish the minimum integrated equipment rating. Series rated equipment shall not be used to meet the minimum ampere interrupting capacity of this switchboard.

B. Future Provisions: All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.

C. Enclosure: Type 1 - General Purpose.

1. Sections shall be aligned front and rear.

2. Switchboard height shall be 91.5 inches including 1.5 inch floor sills and excluding lifting members and pull boxes.

3. The switchboard shall be of a deadfront construction.

4. The switchboard frame shall be of formed steel rigidly bolted together to support all cover plates, bussing and component devices during shipment and installation.

5. Steel base channels shall be bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting.

6. Each switchboard section shall have an open bottom and an individually removable top plate for installation and termination of conduit.

7. The switchboard enclosure shall be painted on all exterior surfaces. The paint shall be a medium gray, ANSI #49, applied by the electro-deposition process over an iron phosphate pre-treatment.

8. All front covers shall be screw removable with a single tool and all doors shall be hinged with removable hinge pins.

9. Top and bottom conduit areas shall be clearly indicated on shop drawings.

D. Nameplates: Provide 1 inch height by 4 inches in width engraved laminated (Gravoply) nameplates for each device. Furnish black letters on a white background for 208/120 volt services; red letters on a white background for 480/277 volt services.

E. Bus Composition: Shall be plated copper. Plating shall be applied continuously to all bus work. The switchboard bussing shall be of sufficient cross-sectional area to meet UL Standard 891 temperature rise requirements. The phase and neutral through-bus shall have an ampacity as shown in the plans. For four-wire systems, the neutral shall be of an equivalent ampacity as the phase bus bar. Tapered bus is not acceptable. For provisions for the addition of future sections shall be provided. Bussing shall include all necessary hardware to accommodate splicing for future additions.

F. Bus Connections: Shall be bolted with Grade 5 bolts and conical spring washers.

G. Ground Bus: Sized per NFPA70 and UL 891 Tables 25.1 and 25.2 and shall extend the entire length of the switchboard. Provisions for the addition of future sections shall be provided.

H. Accessibility: Accessible from the front only of the switchboard.

I. Where switchboards are used as service entrance equipment these switchboards shall bear a service entrance label.

2.3 SWITCHBOARD - INCOMING MAIN SECTION DEVICES

A. Main Circuit Breaker:

1. Electronic trip molded case full function 80 percent rated circuit breaker. Individually fixed 2000 amp frame. Nominal System Voltage: 480/277 volts.

2. Breaker Features as Follows:
   a. Circuit breaker trip system shall be a microprocessor based true RMS sensing design with sensing accuracy through the thirteenth harmonic.
   b. The integral trip system shall be independent of any external power source and shall contain no less than industrial grade electronic components.
   c. The ampere rating of the circuit breaker shall be determined by the combination of an interchangeable rating plug, the sensor size, and the long-time pickup adjustment on the circuit breaker. The sensor size, rating plug and switch adjustments shall be clearly marked on the face of the circuit breaker. Circuit breaker shall be UL listed to carry 80 percent of their ampere rating continuously.
   d. The following time/current response adjustments shall be provided: Each adjustment shall have discrete settings and shall be independent of all the other adjustments: Long Time Pickup; Long Time Delay; Short Time Pickup; Ground Fault Pickup; Short Time Delay (I^2t IN and I^2t OUT); Ground Fault Delay (I^2t IN and I^2t OUT).
   e. Circuit breakers with adjustable short-time function shall be provided with defeatable instantaneous adjustment and 18,000 amp 30 cycle short-time withstand ratings.
   f. A means to seal the rating plug and trip unit adjustments in accordance with NEC Section 240-6(b) shall be provided.
   g. Local visual trip indication for overload, short circuit and ground fault trip occurrences shall be provided.
   h. An ammeter to individually display all phase currents flowing through the circuit breaker shall be provided. Indication of inherent ground fault current flowing in the system shall be provided on circuit breakers with integral ground fault protection. All current values shall be displayed in true RMS with 2 percent accuracy.
   i. Long Time Pickup indication to signal when loading approaches or exceeds the adjusted ampere rating of the circuit breaker shall be provided.
   j. The trip system shall include a Long Time memory circuit to protect against intermittent overcurrent conditions above the long time pickup point. Means shall be provided to reset Long Time memory circuit during primary injection testing.
   k. Circuit breaker shall be equipped with back-up thermal and magnetic trip system.
   l. Circuit breaker trip system shall be equipped with an externally accessible test port for use with a Universal Test Set. Disassembly of the circuit breaker shall not be required for testing. Test set shall be capable of verifying the operation of all trip functions with or without tripping the circuit breaker.
   m. Communications capabilities for remote monitoring of circuit breaker trip system, to include phase and ground fault currents, pre-trip alarm indication, switch settings and trip history information shall be provided.

3. Ground fault protection shall be provided on main circuit breaker operating at 480/277 volts, 3 phase, 4 wire systems rated 1000 amperes or more.

4. All lugs shall be UL listed to accept solid or stranded copper and aluminum conductors. Lugs shall be suitable for 75 degrees Celsius rated wire sizes 1/0 AWG and larger and 60 degrees Celsius rated wire sizes 14 AWG. Lug body shall be bolted in place; snap in designs are not acceptable.

2.4 SWITCHBOARD - DISTRIBUTION SECTION DEVICES

A. Branch Circuit Breakers:

1. Electronic trip molded case standard function 80 percent rated circuit breakers (unless noted otherwise).
   a. Group mounted:
      1) Branch Circuit breakers shall be group mounted with mechanical restraint on a common pan or rail assembly. The interior shall have 3 plat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
      2) Circuit breakers shall not require additional external mounting hardware. Circuit breakers shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breakers of different frame sizes shall be capable of being mounted across from each other.
      3) Line side circuit breaker connections are to be jaw type.

2. Electronic Trip Breaker Features as Follows:
   a. Circuit breaker trip system shall be a microprocessor-based true RMS sensing design with sensing accuracy through thirteenth harmonic.
   b. The integral trip system shall be independent of any external power source and shall contain no less than industrial grade electronic components.
   c. The ampere rating of the circuit breaker shall be determined by the combination of an interchangeable rating plug, the sensor size, and the long-time pickup adjustment on the circuit breaker. The sensor size, rating plug and switch adjustment positions shall be clearly marked on the face of the circuit breaker. Circuit breaker shall be UL listed to carry [100 percent] [80 percent] of their ampere rating continuously.
   d. The following time/current response adjustments shall be provided: Each adjustment shall have discrete settings and shall be independent of all the other adjustments: Long Time Pickup; Long Time Delay; Instantaneous Pickup; Short Time Pickup; Ground Fault Pickup; Short Time Delay (I^2t IN only); Ground Fault Delay (I^2t OUT only).
   e. A means to seal the rating plug and trip unit adjustments in accordance with NEC Section 240-6(b) shall be provided.
   f. Local visual trip indication for overload, short circuit and ground fault trip occurrences shall be provided.
   g. An ammeter to individually display all phase currents flowing through the circuit breaker shall be provided. Indication of inherent ground fault current flowing in the system shall be provided on circuit breakers with integral ground fault protection. All current values shall be displayed in true RMS with 2 percent accuracy.

h. Long Time Pickup indication to signal when loading approaches or exceeds the adjusted ampere rating of the circuit breaker shall be provided.

i. The trip system shall include a Long Time memory circuit to protect against intermittent overcurrent conditions above the long time pickup point. Means shall be provided to reset Long Time memory circuit during primary injection testing.

j. Equipment Ground Fault Module:

1) Circuit breakers shall be equipped with a residual type ground fault module (GFM). The GFM shall be of solid-state construction. The energy required to operate the circuit breaker ground fault tripping mechanism shall be derived from the ground fault current as a result of an output from the internal current sensor; no external power is required.

2) Current settings for the ground fault pick-up point shall be field adjustable from 20 through 100 amperes for 100 ampere ground fault modules and 40 through 200 amperes for 250 ampere ground fault modules. A switch shall be provided for setting the ground fault pick-up point.

k. Terminations:

1) All lugs shall be UL listed to accept solid or stranded copper and aluminum conductors. Lugs shall be suitable for 75 degrees Celsius rated wire sizes 1/0 AWG and larger and 60 degrees Celsius rated wire sizes 14 AWG through 1 AWG. Lug body shall be bolted in place, snap in designs are not acceptable.

2.5 METERING TRANSFORMERS

A. Manufacturer: All instrument transformers shall be UL recognized per Classification XODW2.

B. Current Transformers: ANSI C57.13; 5 ampere secondary, window type, with single secondary winding, primary/secondary ratio as shown on drawings, burden and accuracy consistent with connected metering and relay devices, 60 HZ.

2.6 CUSTOMER METERING

A. A customer meter shall be provided on the main bus. The information and capabilities provided by the meter shall include the following:

1. Current, per phase.

2. Voltage, phase-to-phase and phase-neutral.

3. Real Power (kW), per phase and three phase total.

4. Reactive per (kVAR), per phase and three phase total.

5. Apparent Power (kVA), per phase and three phase total.

6. Power Factor (true), per phase and three phase total.

7. Frequency readings.

8. Real Energy (kWh), three phase total.

9. Reactive Energy (kVARh), three phase total.

10. Apparent Energy (kVAh), three phase total.

11. Energy Accumulation modes, signed, absolute, energy in and energy out.

12. Neutral Current Measurements.

13. Demand Current, per phase and neutral, present and peak.

14. Real Power Demand (kVARd), readings, three phase total, present and peak.

15. Reactive Power Demand (kVARd) readings, three phase total, present and peak.

16. Apparent Power Demand (kVAd) readings, three phase total, present and peak.

17. Total Harmonic Distortion (THD) readings, voltage and current, per phase.

18. Date and Time Stamping, peak demands, power us/restart and resets.

19. Onboard alarms for over/under voltages (per phase L-L, L-N), over/under currents (per phase, neutral), over/under frequency, current unbalance (per phase) and voltage unbalance (per phase L-L, L-N).

20. Minimum and maximum readings.

B. The meter shall be accurate to 0.25 percent of reading plus 0.05 percent of full scale for voltage and current sensing and 0.5 percent of reading plus 0.05 percent of full scale for power and energy, accurate through the thirty first harmonic.

1. These accuracies shall be maintained for both light and full loads.

2. No annual recalibration by users shall be required to maintain these accuracies.

3. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy.

C. The meter shall have a built-in RS-485 data communications to allow multipoint communication to multiple computer workstations, programmable controllers and other host devices, up to a data rate of 19,200 baud.

D. The data communications shall be optically isolated to provide reliable operation.

E. The meter shall be equipped with a backlit, 2-line LCD display.

F. All setup information and reset commands shall be password protected.

G. A KYZ pulse initiator for communication of kWh, kVARh or kVAh information to third party energy management systems shall be provided.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance and operation.

B. Portable Test Set: To test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Circuit Breaker Removal Apparatus: Furnish one portable, floor-supported, roller-based. Elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

D. Circuit Breaker Removal Apparatus: Overhead circuit breaker lifting device, mounted at top front of switchboard with hoist and lifting yokes matching each drawout circuit breaker.

E. Fungus Proofing: Permanent fungicidal treatment for switchboard interior, including instruments and instrument transformers.

2.8 IDENTIFICATION

A. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single line diagram format using symbols and letter designations consistent with final mimic bus diagram. Coordinate mimic bus segments with devices in switchboard sections to which applied. Produce a concise visual presentation of principal switchboard components and connections.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 PREPARATION

A. Provide 4 inch high concrete housekeeping pad under switchboard. Pad shall be the same size as the switchboard. Pin pad to floor.

B. For all equipment rated at 1200 amperes or more and over 6 feet, 0 inches wide, there shall be 1 entrance to the required working space at each end of the working space. Where the entrance has a personnel door, the door shall open in the direction of egress and be equipped with panic bars, pressure plates or other devices that are normally latched but open under simple pressure.

3.3 INSPECTION

A. Examine area to receive switchboard to provide adequate clearance for switchboard installation.

B. Check that concrete pads are level and free if irregularities.

C. Start work only after unsatisfactory conditions are corrected.

3.4 INSTALLATION

A. Install switchboard where shown on the drawings in accordance with manufacturer's written guidelines and NEC and according to NEMA PB 2.1.

3.5 FIELD QUALITY CONTROL

A. Inspect completed installation for physical damage, proper alignment, anchorage and grounding.

B. Measure, using a Megger, the insulation resistance of each bus section phase to phase and phase to ground for one minute each, at minimum test voltage of 1,000 volts DC; minimum acceptable value for insulation resistance is 1 megohms. Refer to manufacturer's literature for specific testing procedures.

C. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.

D. Physically test key interlock systems to check for proper functionality.

E. Test ground fault systems by operating push-to-test button.

3.6 ADJUSTING

A. Adjust all operating mechanisms for free mechanical movement per manufacturer's specifications.

B. Tighten bolted bus connections in accordance with manufacturer's instructions.

3.7 CLEANING

A. Touch up scratched or marred surfaces to match original finish.

3.8 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products in conformance with manufacturer's recommended practices as outlined in applicable installation and maintenance manuals.

B. Each switchboard section shall be delivered in individual shipping splits for ease of handling. They shall be individually wrapped for protection and mounted on shipping skids.

C. Inspect and report concealed damage to carrier within their required time period.

D. Store in a clean, dry space. Maintain factory protection and/or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.

E. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosure and finish.

3.9 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.10 CONNECTIONS

A. Install equipment grounding connections for switchboards with ground consistently to main electrical ground bus.

B. Tighten electrical connections 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 UL486B.

3.11 DEMONSTRATION

A. Engage a factory authorized service representative to train owner's maintenance personnel to adjust, operate and maintain switchboard. Provide eight hours for training.

3.12 APPLICATION

A. Circuit breakers used as switches in 120 volt and 277 volt fluorescent lighting circuits shall be listed and shall be marked SWD or HID. Circuit breakers used as switches in high intensity discharge lighting circuits shall be listed and shall be marked as HID.

B. Provide UL listed (UL 489) circuit breakers for use with heating, air conditioning and refrigeration equipment comprising multimotor or combination loads are marked, "Listed HACR Type". Where the equipment marking specifies fuses or "HACR Type" circuit breakers, the circuit is intended to be protected only by the type of protection device specified.

END OF SECTION 26 24 13

SECTION 26 24 16 - 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. This Section includes the following:

1. Panelboard.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTAL AND RECORD DOCUMENTATION

A. Submit under provisions of Section 260500.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

C. Approval documents shall include drawings. Drawings shall contain overall panel dimensions, interior mounting dimensions and wiring gutter dimensions.

1.4 OPERATIONS AND MAINTENANCE MATERIALS

A. Submit under provisions of Section 260500.

B. Provide installation instructions and NEMA Standards Publication PB 1.1 (Operations and Maintenance Manual) with each panel board.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with NECA Standard of Installation, NEMA PB 1 and NFPA 70.

1.6 FIELD MEASUREMENTS

A. Verify field measurements are as indicated on the Shop Drawings for proper installation of panelboards in accordance with this specification.

B. 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 and encumbrances to workspace clearance requirements.

1.7 MAINTENANCE MATERIALS

A. Provide maintenance materials under provisions of Section 260500.

B. Provide two of each panel board key.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D.

B. General Electric.

C. EATON/Cutler Hammer

2.2 RATINGS

A. Panelboards shall be rated as indicated on the drawings. Continuous main current ratings shall be as indicated on associated schedules. Integrated minimum short circuit ratings shall be in RMS symmetrical amperes at the rated voltage.

2.3 INTERIORS

A. Provide one continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors suitable for bolt-on branch circuit breakers. The bussing shall be fully rated. Bussing shall be Copper.

B. All current carrying parts shall be insulated from ground and phase-to-phase by Noryl high dielectric strength thermoplastic or equivalent.

C. Split solid neutral shall be plated and located in the main compartment up to 225 amperes so all incoming neutral cables may be of the same length. Optional 200 percent rated solid neutral shall be plated copper for non-linear load applications subject to harmonics. 200 percent rated solid neutral shall be self-certified by manufacturer.

D. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have pre-formed twist outs covering unused mounting space.

E. Metal nameplates shall be secured to dead-front with rivets or screws. Sticker or foil nameplates are not permitted. Voltage characteristics, ampere rating, UL listed label and short circuit current rating shall be displayed on the interior.

F. Interiors shall be field convertible for top or bottom incoming feed. Main and sub-feed circuit breakers shall be vertically mounted. Main lug interior up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.

G. Furnish mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

H. Provide a separate equipment grounding conductor terminal bar bonded to the panelboard for the termination of feeder and branch circuit equipment grounding conductors.

2.4 MAIN CIRCUIT BREAKER

A. Molded case circuit breakers shall have an over-center, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be factory calibrated to operate in a 40 degrees Celsius ambient environment. Thermal elements shall be ambient compensating above 40 degrees Celsius.

B. Two and three pole circuit breakers shall have an internal common trip crossbar to provide simultaneous tripping. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the breaker, which allows the user to simultaneously select the desired trip levels of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.

C. Breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL listed for reverse connection without restrictive line or load markings.

D. Circuit breaker escutcheon shall have International I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the “ON” or “OFF” position.

E. Lugs shall be UL listed to accept solid or stranded copper and aluminum conductors. Lugs shall be suitable for 75 degrees Celsius rated wire sizes 1/0 AWG and larger and 60 degrees Celsius rated wire sizes 14 AWG through 1 AWG.

F. The breakers shall be UL listed for use with the following accessories: Shunt trip; Under Voltage Trip; Ground Fault Shunt Trip; Auxiliary Switch; Alarm Switch; Mechanical Lug Kits; Compression Lug Kits.

G. Fault current series rated type breakers are not acceptable.

2.5 BRANCH CIRCUIT BREAKERS

A. Breakers shall be UL listed with amperage ratings, interrupting and number of poles as indicated on the panel schedules.

B. Molded case branch circuit breakers shall have bolt-on type bus connectors.

C. Circuit breakers shall have an over-center toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two and three pole circuit breakers shall have an internal common trip crossbar to provide simultaneous tripping.

D. Breakers marked “Remote Controlled” on the panel schedules shall be of the latching type. Circuit breaker contacts shall open when the breaker is in the “OFF” or “TRIPPED” position regardless of the remote signal.

E. There shall be two forms of visible trip indication. The breaker handle shall reside in a “TRIPPED” position between “ON” and “OFF”. In addition, there shall be a VISI-TRIP indicator appearing in the clear window of the circuit breaker housing.

F. The exposed faceplates of all branch circuit breakers shall be flush with one another.

G. Lugs shall be UL listed to accept solid or stranded copper and aluminum conductors. Lugs shall be suitable for 75 degrees Celsius rated wire sizes 1/0 AWG and larger and 60 degrees Celsius rated with sizes 14 AWG through 1 AWG. Branch breakers rated 30 amperes and below shall be UL listed to accept 60 degrees C rated wiring.

H. Breakers shall be UL listed for use with the following factory installed accessories: Shunt Trip; Auxiliary Switch; Alarm Switch.

I. Where indicated on the panel schedule, provide panel mounted power supply to provide 24 volts DC switching power for remote controlled circuit breakers.

J. Fault current series rated type breakers are not acceptable.

2.6 ENCLOSURES

A. Type NEMA 1 Boxes

1. Shall be galvanized steel. Galvanealed steel will not be acceptable.

2. Boxes shall have removable end walls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.

3. Minimum box dimensions shall be 20 inches wide by 5 ¾ inches deep.

B. Type NEMA 1 Trim Fronts:

1. Shall have ANSI 49 grey enamel electrodeposited over cleaned phosphatized steel.

2. Trim fronts shall be hinged one piece with door. Mounting shall be as indicated on associated panel schedules on the drawings. Multiple section panels shall have a separate trim front for each section.

3. Panelboards rated 225 amperes and below shall have MONO-FLAT fronts with concealed door hinges and trim screws. Front is not removable with the door locked. Panelboards rated above 225 amperes shall have fronts with trim clamps and concealed door hinges. Trim front doors shall have rounded corners and edges shall be free of burrs.

4. Front shall have cylindrical tumbler lock with catch and spring loaded stainless steel door pull. All lock assemblies shall be keyed alike. Two keys shall be provided with each lock. A clear plastic directory cardholder shall be mounted on the inside of door.

C. Type NEMA 4X Trim Fronts:

1. Shall be brushed stainless steel, type 304/316.

2. All doors shall be gasketed and equipped with a tumbler type vault lock and two additional trunk latches. All lock assemblies shall be keyed alike. Two keys shall be provided with each lock. A clear plastic directory cardholder shall be mounted on the inside of the door.

D. Type NEMA 3R, NEMA 3S and NEMA 12:

1. Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.

2. All doors shall be gasketed and equipped with a tumbler type vault lock and two additional trunk latches. All lock assemblies shall be keyed alike. Two keys shall be provided with each lock. A clear plastic directory cardholder shall be mounted on the inside of the door.

3. Maximum enclosure dimensions shall not exceed 20 inches wide and 6.5 inches deep.

2.7 SURGE PROTECTION DEVICE

A. Provide external SPD for all “Computer” panelboards (CPX).

B. Refer to section 264313 for device information.

C. Provide internal circuit breaker, sized as required by manufacturer, for SPD connection. Maintain shortest possible leads.

2.8 CUSTOMER METERING

A. Energy usage metering shall be provided adjacent to the following Distribution Panelboard feeders:

B. Provide energy usage metering for the following breakers in switchboard ‘MDS’.

1. Panel ‘LPD’
2. Panel ‘RPD’
3. Panel ‘CPD’
4. Panel ‘HP6’
5. Panel ‘HP7’

C. Provide energy usage metering for the following breakers in panelboard ‘SMDS’.

1. Panel ‘LPK’
2. Panel ‘LP4’
3. Panel ‘SRPD’
4. Panel ‘HPD’
5. Panel ‘CP4’

D. The information and capabilities provided by the meter shall include the following:

1. Current, per phase.
2. Voltage, phase-to-phase and phase-neutral.
3. Real Power (kW), per phase and three phase total.
4. Reactive per (kVAR), per phase and three phase total.
5. Apparent Power (kVA), per phase and three phase total.
6. Power Factor (true), per phase and three phase total.
7. Frequency readings.
8. Real Energy (kWh), three phase total.
9. Reactive Energy (kVARh), three phase total.
10. Apparent Energy (kVAh), three phase total.
11. Energy Accumulation modes, signed, absolute, energy in and energy out.

12. Neutral Current Measurements.

13. Demand Current, per phase and neutral, present and peak.

14. Real Power Demand (kVARd), readings, three phase total, present and peak.

15. Reactive Power Demand (kVARd) readings, three phase total, present and peak.

16. Apparent Power Demand (kVAd) readings, three phase total, present and peak.

17. Total Harmonic Distortion (THD) readings, voltage and current, per phase.

18. Date and Time Stamping, peak demands, power us/restart and resets.

19. Onboard alarms for over/under voltages (per phase L-L, L-N), over/under currents (per phase, neutral), over/under frequency, current unbalance (per phase) and voltage unbalance (per phase L-L, L-N).

20. Minimum and maximum readings.

E. The meter shall be accurate to 0.25 percent of reading plus 0.05 percent of full scale for voltage and current sensing and 0.5 percent of reading plus 0.05 percent of full scale for power and energy, accurate through the thirty first harmonic.

1. These accuracies shall be maintained for both light and full loads.

2. No annual recalibration by users shall be required to maintain these accuracies.

3. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy.

F. The meter shall have a built-in RS-485 data communications to allow multipoint communication to multiple computer workstations, programmable controllers and other host devices, up to a data rate of 19,200 baud.

G. The data communications shall be optically isolated to provide reliable operation.

H. The meter shall be equipped with a backlit, 2-line LCD display.

I. All setup information and reset commands shall be password protected.

J. A KYZ pulse initiator for communication of kWh, kVARh or kVAh information to third party energy management systems shall be provided.

K. The meter shall be able to communicate with Building Automation System (BAS) via communications interface with BAS system protocol (BACnet, Modbus), via Ethernet connection. Coordinate systems protocol with supplied BAS in the field.

L. Meters shall be Square-D Model PM820 or Equal.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Install panelboards in accordance with manufacturer's written instructions, NEMA PB 1.1 and NEC standards.

B. Install panelboards plumb. Install recessed panelboards flush with wall finishes. Provide supports in accordance with Section 260529.

C. Anchor panelboards to structure and make branch circuit connections.

D. Coordinate the panelboard bus ratings and circuit breaker coordination rating with the available fault current.

E. Provide engraved laminated nameplates and panelboard directories under the provisions of Section 260553.

F. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Minimum spare conduits; five empty one inch. Identify each as "SPARE".

G. For all indicated scheduled emergency and normal/emergency panelboards, Contractor shall provide breaker locks on all branch circuit breakers associated with respective panel.

H. Enclosures for over-current devices shall be mounted in a vertical position unless that is impractical; circuit breakers may be installed horizontally as long as the up position of the handle is the "on" position.

I. Provide main breaker for power panelboard with supply conductors that include a neutral and having more than 10 percent of its overcurrent devices protecting branch circuits rated 30 amperes or less with a rating not greater than that of the panelboard.

J. Mounting heights: Top of trim - 74 inches above finished floor unless noted otherwise.

K. All branch circuits that supply electric heat tracing shall be protected by ground-fault equipment protection circuit-interrupters (GFEPCI).

3.3 FIELD QUALITY CONTROL

A. Inspect complete installation for physical damage, proper alignment, anchorage and grounding.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within ten percent of each other. Maintain proper phasing for multi-wire branch circuits.

C. Check tightness of bolted connections, and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

3.4 APPLICATION

A. Circuit breakers used as switches in 120 volt and 277 volt florescent lighting circuits shall be listed and shall be marked SWD or HID. Circuit breakers used as switches in high intensity discharge lighting circuits shall be listed and shall be marked as HID.

B. Provide UL listed (UL489) circuit breakers for use with heating, air conditioning and refrigeration equipment comprising multimotor or combination loads are marked "Listed HACR Type". Where the equipment marking specifies fuses or "HACR Type" circuit breakers the circuit is intended to be protected only by the type of protection device specified.

3.5 DELIVERY, STORAGE AND HANDLING

A. Inspect and report concealed damage to carrier within their required time period.

B. Handle carefully to avoid damage to panel board internal components, enclosure and finish.

C. Store in a clean, dry environment. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water construction debris and traffic.

END OF SECTION 26 24 16

SECTION 26 27 00 - ELECTRIC SERVICE

PART 1 - GENERAL

1.1 STIPULATIONS

A. General provisions of the Contract Documents including General and Supplementary Conditions and Division 1 Specifications Sections apply to all work in this section.

B. The Specification Sections “General Conditions” and “Special Requirements” form a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 WORK INCLUDED

A. Arrangement with utility company for permanent electric service.

B. Underground service entrance.

1.3 SYSTEM DESCRIPTION

A. Utility Company: Baltimore Gas and Electric (BG&E).

1. System Characteristics: 480Y/277 volts, 3 phase, 4 wire, 60 Hertz.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with utility company written requirements.

B. Maintain one copy of each document on site.

1.5 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

1.6 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on utility company drawings.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 UTILITY/CONTRACTOR COORDINATION

A. BG&E will provide the following:

1. Pad mounted transformer and ground grid around transformer.

2. All primary cable with connectors and connections.

3. Electric metering current transformers inside the current transformer cubicle of the main distribution board with wiring and connections.

4. Furnish electric meter enclosure for installation by the Division 26 Contractor.

5. Secondary cables between transformer and current transformer including connections to line side of current transformer.

B. Division 26 Contractor will provide the following:

1. Existing Transformer foundation per BG&E requirements shall be reused.

2. Excavation, backfilling and concrete encased conduits for the main secondary feeder and fire pump feeder from the transformer to the current transformer cabinet.

3. Install electric meter inside building adjacent to CT cabinet building per BG&E requirements.

4. 1-1/4 inch conduit from the current transformer cabinet to the meter location.

C. Division 26 Contractor shall contact Karl Core with BG&E at 410-838-7484 for specific instructions regarding their service requirements before beginning this phase of his work. All service work shall be in complete compliance with BG&E requirements, codes and regulations.

D. Electrical Contractor shall be responsible for all costs incurred by BG&E to bring electric service to building.

E. Make all arrangements necessary to obtain electrical service from BG&E.

F. Obtain all necessary standards and detail drawings from BG&E before construction of service equipment is commenced.

G. BG&E's service data as shown is accurate as determined on the date of specification issue and shall be verified as specified herein above.

H. Verify that service equipment is ready to be connected and energized.

END OF SECTION 26 27 00

SECTION 26 27 26 - WIRING DEVICES AND WALL PLATES

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. Wall switches.

2. Occupancy sensors.

3. Receptacles.

4. Wall plates.

5. Pushbuttons.

6. Photoelectric cells.

7. Time clock.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTALS

A. Submit under provisions of Section 260500.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

C. Manufacturer's Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements.

2. Include instructions for storage, handling, protection, examination, preparation, operation and installation of product.

D. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2:For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. The color of the devices on this project shall be white.

1. Manufacturers
   a. Pass & Seymour, PS20AC1
   b. Hubbell.
   c. Leviton.
   d. Cooper.

B. Description: NEMA WD 1, heavy-duty, binding screw type for back and side wiring, AC only general-use snap switch with grounded mounting strap, and grounding terminal with green screw.

C. Toggle Color: White.

D. Types: Switch shall be single pole, three-way, or four-way as required by the drawings.

E. Voltage Rating: 120-277 volts, AC.

F. Current Rating: 20 amperes.

2.2 WEATHERPROOF SWITCH

A. Manufacturer:

1. Pass & Seymour, Cat. No. CA33

2. Hubbell.

3. Leviton.

4. Cooper.

5. Bryant.

B. Description: Single gang, single pole or 3 way as indicated on the drawings, lever switch with aluminum plate, stainless steel screws, and gasketing. Switch shall be U.L. listed for outdoor use.

C. Color shall be Gray.

2.3 OCCUPANCY SENSORS

A. Manufacturer:

1. Watt Stopper (Model numbers indicated)

2. Lutron.

3. Leviton.

4. Hubbell.

5. Cooper Controls/EATON.

6. Crestron.

7. Sensor Switch.

B. Description:

1. The occupancy sensors shall sense the presence of human activity within the desired room and control the on/off function of the room lights automatically.

2. The occupancy sensors shall turn lighting off automatically after a preset time delay when a room or area is vacated by the last person to occupy the said room or area. Field adjustable time delay settings must be available.

3. All devices shall be UL listed, offer a 5 year warranty and meet all applicable State and local code requirements.

4. Products supplied shall be from a single manufacturer. Mixing of manufacturers shall not be allowed.

C. Work Included:

1. The Contractor’s work shall include all labor, materials, tools, appliances, control hardware, sensors, wire, junction boxes and equipment necessary for the installation of a completely operational occupancy sensor based lighting control system.

2. The Contractor shall warrant all equipment furnished in accordance with this specification to be undamaged, free of defects in material and workmanship and in

conformance with the specifications. Warranty on labor shall be for 1 year and shall commence upon the Owner's acceptance of the project.

3. The equipment manufacturer/supplier shall include testing, repair and/or replacement, without charge to the Owner, of any or all parts of equipment which are found to be damaged, defective or non-conforming.

D. Submittals:

1. Manufacturer shall substantiate conformance to this specification by supplying the necessary performance data, catalog literature, performance specifications, wiring diagrams and interconnection diagrams.

2. Manufacturer shall submit a lighting drawing clearly showing proper product, location and orientation of each occupancy sensor used.

3. It shall be the Contractor's responsibility to make all proper adjustments to assure Owner's satisfaction with the occupancy system. Unless specified otherwise, the Contractor shall set all time delays to no less than 15 minutes.

E. Equipment Types:

1. Wall Switch Sensors: 2-wire, completely self contained PIR sensor that fits into a standard single gang box. Compatible with electronic ballasts, compact fluorescent and inductive loads. Rated to switch loads up to 800W @ 120V and 1200W @ 277V. 180° coverage.
   a. Model #WA-200 – PIR, 300ft².
   b. Model #WA-300 – PIR (dual relay), 300ft².
   c. Model #WI-200 – PIR, 1000ft².
   d. Model #WI-300 – PIR (dual relay), 1000 ft².

2. Automatic Time Switch: Single-gang, digital time switch compatible with all electronic ballasts and motor loads. Line or low voltage as indicated on drawings. Incremental time-out adjustments 5 min. to 12 hrs. Optional audible and visual warnings.
   a. Model #TS-400 – 120V.
   b. Model #TS-400-24 – 24V.

3. Ceiling Sensors: 24V DC, passive infrared, ultrasonic or dual technology sensors compatible with electronic ballasts, compact fluorescent and rated motor loads. Ceiling or corner mounted as indicated.
   a. Model #WPIR – PIR, 300 ft², ceiling mount.
   b. Model #CX-100 – PIR, 2000², wall/ceiling mount.
   c. Model #CX-100-1 – PIR, long range, 90 linear ft.
   d. Model #W-500A – Ultrasonic, 500 ft².
   e. Model #W-1000A – Ultrasonic, 1000 ft².
   f. Model #W-2000A - Ultrasonic, 2000 ft².
   g. Model #W-2000H – Ultrasonic, long range, 90 linear ft.
   h. Model #WT-2255 – Ultrasonic, hallway sensor, 90 linear ft. 360º.
   i. Model #DT-200 – Dual, 2000 ft², wall/ceiling mount.
   j. Model #DT-300 – Dual, 2000 ft², ceiling mount.

4. Power Packs: Plenum rated, self-contained transformer and high-current relay. 24V DC operating voltage capable of switching 20A ballast load. 1 per circuit or control zone.
   a. Model #B120E-P – 120V.
   b. Model #B277E-P – 277V.
   c. Model #BZ-100 – dual voltage 120/277V.

F. Wall switch sensors shall have no leakage current to load, in manual or in Auto/Off mode for safety purposes and shall have voltage drop protection.

G. Wall switch sensors shall provide a field selectable option to convert sensor operation from automatic-ON to manual-ON.

H. Vandal resistant wall switch sensors shall utilize a hard lens with a minimum 1.0mm thickness. Products utilizing a soft lens will not be considered.

I. Passive infrared sensors shall respond only to those signals caused by human motion.

J. Passive infrared sensors shall provide high immunity to false triggering from RFI (hand-held radios) and EMI (electrical noise on the line), superior performance and optimum reliability.

K. Where specified, passive infrared and dual technology sensors shall offer daylighting foot-candle adjustment control and be able to accommodate dual level lighting.

L. Dual technology sensors shall be corner mounted to avoid detection outside the controlled area when doors are left open.

M. Dual technology sensors shall consist of passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound shall not be considered.

N. Ultrasonic sensors shall adjust the detection threshold dynamically to compensate for constantly changing levels of activity and airflow throughout controlled space.

O. Ultrasonic operating frequency shall be crystal controlled to within +0.005% tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.

P. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.

Q. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.

R. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.

S. In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.

T. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.

U. Where specified, sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.

V. All sensors shall have UL rated, 94V-0 plastic enclosures.

W. Circuit Control Hardware – CU:

1. Control Units - For ease of mounting, installation and future service, control unit(s) shall be able to externally mount through a 1/2" knock-out on a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Control unit shall provide power to a minimum of 2 sensors.

2. Relay Contacts shall have ratings of:
   a. 13A - 120 VAC Tungsten.
   b. 20A - 120 VAC Ballast.
   c. 20A - 277 VAC Ballast.

3. Control wiring between sensors and controls units shall be Class II, 18-24 AWG, stranded U.L. Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums, where applicable.

4. Minimum acceptable wire gauge from the circuit control hardware relays shall be #14 AWG.

X. Installation:

1. It shall be the contractor's responsibility to locate and aim sensory in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have 90% to 100% coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms, which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room. Power/switch packs may or may not be indicated on the drawings. It shall be the contractor’s responsibility to provide and install all power/switch packs required to make the system fully operational. Locations of power/ switch packs may be determined in the field by the contractor unless specified otherwise, but must be readily accessible for future servicing. Usually, a minimum of 1 power/switch pack is required per circuit and/or area of control. However, in some cases additional power/switch packs may be required. Contact manufacturer for final determination of power/switch packs required for this project.

2. It is the contractor’s responsibility to arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the owner's facility, to verify placement of sensors and installation criteria.

3. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. The contractor shall also provide, at the owner's facility, the training necessary to familiarize the owner's personnel with the operation, use, adjustment and problem solving diagnosis of the occupancy sensing devices and systems.

2.4 RECEPTACLES

A. The color of the devices on this project shall be white, unless noted otherwise.

1. Duplex Convenience Receptacle, tamper resistant.
   a. Pass & Seymour, Catalog Number TR5362W.
   b. Hubbell.
   c. Leviton.
   d. Cooper.

2. Duplex Computer Receptacle, tamper resistant, gray in color.
   a. Pass & Seymour, Catalog Number TR5362GRY.
   b. Hubbell.
   c. Leviton.
   d. Cooper.

3. Duplex Receptacle (on generator), tamper resistant, red in color.
   a. Pass & Seymour, Catalog Number TR5362RED.
   b. Hubbell.
   c. Leviton.
   d. Cooper.

4. Duplex Controlled/Switched Receptacle, tamper resistant.
   a. Pass & Seymour, Catalog Number TR5362W(GRY)(RED).
   b. Hubbell.
   c. Leviton.
   d. Cooper.
   e. Prefer factory applied “power” symbol with “CONTROLLED” identification.
   f. Provide custom engraved device plate, “Controlled Receptacle”.

5. Ground Fault Circuit Interrupter (GFCI) Receptacle, tamper resistant:
   a. Pass & Seymour, Catalog Number 2095W(GRY)(RED).
   b. Hubbell.
   c. Leviton.
   d. Cooper.
   e. GFCI receptacles shall not be connected to protect downstream devices, unless noted otherwise on the drawings.

6. Duplex Receptacle with dual USB “A” outlets:
   a. Pass & Seymour, Catalog Number TR5362USB.
   b. Hubbell.
   c. Leviton.
   d. Cooper.

7. Weatherproof Receptacle:
   a. Consisting of a GFCI receptacle as specified above in an outlet enclosure that is UL listed for wet locations, and meet NEC and OSHA requirements while in use.
   b. Manufacturer – Pass & Seymour, Catalog number 2095TRWR with WIUC10-CL cover.

2.5 SPECIAL PURPOSE RECEPTACLES

A. Manufacturers:

1. Hubbell.

2. Leviton.

3. Bryant.

4. Pass & Seymour.

5. Cooper.

B. Description: Polarized, grounding type.

C. Device Body: Black nylon.

D. Configuration: As required by the amperage and voltage of the equipment to be connected on the drawings.

E. Provide equipment cord and caps as required for equipment.

2.6 WALL PLATES

A. Wall plates shall be type 302, satin-finished stainless steel. Screws shall be stainless steel with countersunk heads and finished to match plates.

B. Provide a wall plate on all wiring devices installed under this project.

C. Use gang plates where more than one device is installed at the same location.

2.7 START/STOP PUSHBUTTON

A. In the Kitchen, Start/Stop pushbutton shall be heavy duty, surface mounted, NEMA 1-B with stainless steel flush plate.

B. Start/Stop pushbutton shall be Square D, EATON/Cutler-Hammer, General Electric.

2.8 EMERGENCY STOP PUSHBUTTON WITH KEY RESET

A. Where shown on the Drawings, Emergency Stop pushbutton shall be provided with key switch reset and shall be ASCO Bulletin #173, or Square D Class 9001, type K2L1R20H13 illuminated pushbutton with red color cap, KN-105 legend, KS-34K1 key operated switch, KA-2 contact block, KN-123 legend and K-26 enclosure (flush). Provide stainless steel plate.

2.9 PHOTOELECTRIC CELLS

A. Manufacturer:

1. Paragon Electric Co., Inc.

2. Allen-Bradley.

3. Tork, Inc.

4. Intermatic, Inc.

B. Photoelectric cells shall be weatherproof, self-contained and designed to mount to outdoor junction box or conduit. Units shall be unaffected by moisture, vibration or changes of temperature and shall be contained within a weatherproof Lexan or die-cast aluminum housing.

C. Photoelectric cells shall feature:

1. Capacity: 1800 -watt tungsten or 1800 VA, at 120 or 208-277 volts.

2. Contacts: SPST or SPDT; normally closed.

3. Delay: 15 seconds to minimum nuisance switching.

2.10 TIME CLOCK

A. Manufacturer:

1. Tork, Inc.

2. Paragon Electric Co., Inc.

3. Intermatic, Inc.

4. Zenith Controls, Inc.

B. Description: 2 channel, astronomic capable of controlling electrically operated-mechanical held contactors, 72-hour memory back up with rechargeable battery.

C. Voltage: 120 VAC.

D. Enclosure: NEMA 1.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Verify outlet boxes are installed at proper height.

B. Verify wall openings are neatly cut and will be completely covered by wall plates.

C. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

D. Verify openings in access floor are in proper locations.

3.3 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.4 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Do not share neutral conductor on load side of dimmed circuits.

E. Install receptacles with grounding pole on top.

F. Connect wiring device grounding terminal to outlet box with bonding jumper and to branch circuit equipment grounding conductor.

G. Install wall plates on switches, receptacles, and blank outlets.

H. Use jumbo size plates for outlets installed in masonry walls.

I. Install zinc or cadmium plated steel plates on surface mounted cast Feralloy boxes and junction boxes.

J. Install stainless steel plates on surface mounted cast aluminum boxes.

K. For all new kitchens located in “other than dwelling units,” ground fault circuit interrupter receptacles shall be installed at all locations and not limited to countertop receptacles.

L. Ground fault circuit interrupter receptacles shall be provided within twenty-five feet, zero inches of all HVAC equipment and not limited to equipment on rooftops, attics and crawl spaces.

M. Receptacles installed outdoors in a wet location shall have an enclosure that is weatherproof whether or not the attachment plug cap is inserted.

N. All 15 and 20 amp receptacles located in elevator hoistways, pits, cartops shall be GFCI type.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes provided under Section 260534 to obtain mounting heights indicated on drawings.

3.6 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

3.7 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

END OF SECTION 26 27 26

SECTION 26 28 13 - 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. This Section includes the following:

1. Fuses.

2. Spare fuse cabinet.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTALS

A. Submit under provisions of Section 260500.

B. Product Data: Provide data sheets showing electrical characteristics including time-current curves.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

1.4 QUALITY ASSURANCE

A. Provide fuses from a single manufacturer.

B. Record actual fuse sizes.

C. Comply with NEMA FU 1.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years experience.

1.6 MAINTENANCE MATERIALS

A. Provide two fuse pullers.

1.7 COORDINATION

A. Coordinate fuse rating with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

1.8 EXTRA MATERIALS

A. Provide three of each size and type fuse installed.

B. Fuse pullers: For each size fuse.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Littelfuse.

B. Buss.

C. Economy.

D. Gould-Shawmut.

2.2 FUSE REQUIREMENTS

A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.

B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

C. Nonrenewable cartridge.

D. Provide rejection clips for fuse holders with Type R fuses.

2.3 SPARE FUSE CABINET

A. Description: Wall-mounted sheet metal cabinet, suitably sized to store spare fuses and fuse pullers specified.

B. Doors: Hinged, with hasp for Owner's padlock.

C. Finish: Prime finish for field painting.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Provide fuse types as required for project conditions. Fuse size shall be as indicated on the drawings.

B. Install fuses in accordance with manufacturer's instructions.

C. Install fuses in all active fuse clips.

D. Install fuse with label oriented such that manufacturer, type and size are easily read.

E. Install spare fuse cabinet where directed by Owner.

3.3 FUSE APPLICATIONS

A. Motor Branch Circuits: Class RK1, time delay.

B. Other Branch Circuits: Class RK1, time delay.

END OF SECTION 26 28 13

SECTION 26 28 14 - CABINETS AND ENCLOSURES

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. Hinged cover enclosures.

2. Cabinets.

3. Terminal blocks and accessories.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTALS

A. Submit product data under provisions of Section 260500.

B. Shop Drawings for Equipment Panels: Include wiring schematic diagram, wiring diagram, outline drawing and construction diagram as described in ANSI/NEMA ICS 1.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

PART 2 - PRODUCTS

2.1 HINGED COVER ENCLOSURES

A. Construction: NEMA 250, type 3R steel.

B. Finish: Manufacturer's standard enamel finish.

C. Covers: Continuous hinge, held closed by flush latch operable by hasp and staple for padlock.

D. Panel for Mounting Terminal Blocks or Electrical Components: 14 gauge steel, white enamel finish.

2.2 CABINETS

A. Cabinet Boxes: Galvanized steel with removable end walls, 24 inches wide, 24 inches high, 6 inches deep.

B. Cabinet Fronts: Steel, flush/surface type with concealed trim clamps concealed hinge and flush lock keyed to match branch circuit panelboard; finish in gray baked enamel.

2.3 TERMINAL BLOCKS AND ACCESSORIES

A. Terminal Blocks: ANSI/NEMA ICS 4, UL listed.

B. Power Terminals: Unit construction type, closed back type, with tubular pressure screw connectors, rated 600 volts.

C. Signal and Control Terminals: Modular construction type, channel mounted, tubular pressure screw connectors; rated 300 volts.

2.4 FABRICATION

A. Shop assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with ANSI/NEMA ICS 6.

B. Provide knockouts on enclosures.

C. Provide protective pocket inside front cover with schematic diagram, connection diagram and layout drawing of control wiring and components within enclosure.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum.

B. Provide accessory feet for free-standing equipment enclosures.

C. Install trim plumb.

END OF SECTION 26 28 14

SECTION 26 28 16 - DISCONNECT SWITCHES

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. Disconnect switches.
   a. Heavy duty type.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTALS

A. Submit product data under provisions of Section 260500.

B. Include outline drawings with dimensions, and equipment ratings for voltage, capacity, horsepower and short circuit.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - DISCONNECT SWITCHES

A. Square D.

B. General Electric.

C. EATON/Cutler Hammer

2.2 HEAVY DUTY TYPE

A. All switches shall have switchblades that are visible when the switch is OFF and the cover is open.

B. Lugs shall be front removable and UL listed for 60 degrees Celsius or 75 degrees Celsius conductors in switches rated 30-100 ampere, 75 degrees Celsius conductors in switches rated 200-1200 ampere, aluminum or copper conductors (Type 1, 3R or 4X polyester), copper conductors only (Type 12, 12K, Type (4, 4X, 5) stainless steel).

C. Switches required for Type 12, 12K or Type (4, 4X, 5) stainless steel applications shall have all copper current carrying parts.

D. All current carrying parts shall be plated to resist corrosion.

E. Switches shall have removable ARC suppressors to facilitate easy access to line side lugs.

F. Switches shall have provisions for a field installable electrical interlock.

G. Switch operating mechanism shall be quick-make, quick-break such that, during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing or opening action of the contacts has started.

H. The operating handle shall be an integral part of the box, not the cover.

I. The handle position shall travel at least 90 degrees between OFF and ON positions to clearly distinguish and indicate handle position.

J. All switches shall have a dual cover interlock mechanism to prevent unintentional opening of the switch cover when the switch is ON and prevent turning the switch ON when the cover is open. The cover interlock mechanism shall have an externally operated override but the override shall not permanently disable the interlock mechanism. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

K. Switch enclosure shall be NEMA 1 unless noted otherwise on the drawings or required by the NEC in accordance with the project conditions.

L. The enclosure shall be finished with gray baked enamel paint which is electrodeposited on cleaned, phosphate pre-treated steel (Type 1), gray baked enamel paint which is electrodeposited on cleaned, phosphate pre-treated galvannealed steel (Type 3R, 12, 12K), a brush finish on Type 304 stainless steel (Type 4, 4X, 5 stainless steel), gray baked enamel on copper free cast aluminum allow (Type 7/9).

M. The enclosure shall have ON and OFF markings on the cover to clearly identify the position of the switch.

N. All switches shall have provisions to accept up to 3-3/8 inch hasp padlocks to lock the operating handle in the OFF position.

O. Tangential knockouts shall be provided to facilitate ease of conduit entry Type 1, 3R, 12K for switches rated 30-200A.

P. Type 12 and (4, 4X, 5) stainless steel enclosure shall contain no knockouts. Supply watertight hubs as required.

Q. Type 4X polyester enclosures shall be provided with polyester conduit hubs for field installation.

R. Type 7/9 enclosures shall be provided with threaded conduit openings in both end walls.

S. Enclosures for Type 3R switches through 200 ampere shall have provisions for interchangeable bolt-on hubs in the top end wall.

T. Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor applications.

U. Type 12, 4, 4X and 5 stainless steel enclosures shall be dual rated as Type 3R to facilitate their use in outdoor applications.

V. Cover viewing window will be incorporated on 30-200A NEMA 12, 12K, 4, 4X, and 5 stainless steel; 2 or 3 pole switches.

W. Switches shall be horsepower rated for AC and/or DC as indicated on the plans.

X. The UL listed short circuit current rating of the switches shall be: 10,000 RMS symmetrical amperes when used with or protected by Class H or K fuses (30-600 ampere).; 200,000 RMS symmetrical amperes when used with or protected by Class R or J fuses (30-600 ampere switches employing appropriate fuse rejection schemes).; 200,000 RMS symmetrical amperes when used with or protected by Class L fuses (800-1200 ampere).

2.3 SWITCH ACCESSORIES

A. Where switches are designated for use at service entrance, the switch shall be labeled for such use.

B. Where fuse switches are designated to have Type R fuses, the switch shall be provided with rejection clips.

C. Provide auxiliary contacts on disconnect switches for main power to elevator controllers equipped with an automatic lowering device. Auxiliary contacts shall be open when switch is in the open position.

D. Safety switches used as a local disconnect for a motor circuit shall be furnished with auxiliary contacts connected with 2#14 control wires to interrupt the starter control circuit when the disconnect switch is opened.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Install disconnect switches where indicated on the drawings.

B. Install fuses in fusible disconnect switches.

C. Install disconnecting means for air conditioning or refrigerating equipment within sight and readily accessible from the equipment. It is permitted to be installed on or within the equipment but is prohibited from being installed on the unit access panel.

END OF SECTION 26 28 16

SECTION 26 28 17 - CIRCUIT BREAKER ENCLOSURES

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. Enclosures for circuit breakers.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SERVICE ENTRANCE

A. Circuit breaker enclosures identified for use as service entrance are to be labeled for this application.

1.4 SUBMITTALS

A. Provide outline drawings with dimensions, and voltage, amperage and integrated equipment short circuit current ratings.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D.

B. General Electric.

C. EATON/Cutler Hammer

2.2 OPERATING MECHANISM

A. The circuit breaker operating handle shall be externally operable.

B. Provisions for padlocking the circuit breaker in the OFF position shall be provided.

C. Enclosures designated as Type (4, 4X, 5) 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 prevent turning the circuit breaker ON when the enclosure cover is open. The cover interlock mechanism shall have an externally operated override but the override shall not permanently disable the interlock mechanism. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

2.3 ENCLOSURE

A. Enclosure shall comply with NEMA 1 Construction Standards unless otherwise noted on the drawings.

B. The enclosure shall be finished with gray baked enamel paint which is electrodeposited on cleaned, phosphatized steel (Type 1), gray baked enamel paint which is electrodeposited on cleaned, phosphatized galvannealed steel (Type 3R, 12, 12K), a brush finish on Type 304 stainless steel (Type 4, 4X, 5) stainless steel, copper free cast aluminum alloy (Type 7, 9).

C. Type 12, 4, 4X, 5 enclosures shall be dual rated as Type 3R to facilitate their use in outdoor applications.

D. Type 12, 4, 4X, 5 stainless steel enclosures shall contain no knockouts; supply water tight hubs as indicated on the plans.

E. Type 7 and 9 enclosures shall be provided with threaded conduit openings in both end walls.

2.4 ENCLOSURE RATINGS

A. The integrated equipment short circuit current rating shall be equal to the interrupting rating at the supply voltage marked on the circuit breaker installed, up to 200,000 RMS symmetrical amperes short circuit current, or as shown on enclosure wiring diagram.

2.5 THERMAL MAGNETIC MOLDED CASE CIRCUIT BREAKERS

A. Circuit breakers shall be High interrupting construction. Ampere ratings shall be as shown on the drawings.

B. All circuit breakers shall be UL listed for reverse connection without restrictive line and load markings and be suitable for mounting in any position.

C. Circuit breakers shall be constructed using glass reinforced insulating material providing superior dielectric strength. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

D. Each circuit breaker shall have common tripping of all poles and shall be trip free.

E. The circuit breakers shall be quick-make, quick-break with an over center toggle operating mechanism. Shall not be able to be teased into a neutral position.

F. Breaker handle and faceplate shall indicate rated ampacity. Breaker faceplate shall indicate UL and IEC certification standards with applicable voltage systems and corresponding AIC ratings.

G. Circuit breakers shall be factory sealed and shall have a date code on the face of the circuit breaker. Poles shall be labeled with respective phase designations.

H. Handle position shall provide local trip indication.

I. Circuit breaker escutcheon shall have International I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the “ON” or “OFF” position.

J. Each circuit breaker shall be equipped with a push-to-trip button to mechanically operate the circuit breaker tripping mechanism.

K. All circuit breakers shall be applied on systems where the available short circuit current on the line side of the device is less than or equal to the interrupting rating of the circuit breaker.

L. Circuit breakers shall be UL listed for use with the following accessories: Shunt Trip.; Auxiliary Switch.; Ground Fault Shunt Trip.; Mechanical Lugs Kits.; Handle Accessories.

M. Trip System

1. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole.

2. All circuit breakers shall have factory sealed thermal trip elements. The thermal trip system shall be true RMS sensing and thermally responsive to protect circuit connector(s) in a 40 degrees Celsius ambient temperature. Thermal elements shall be ambient compensating above 40 degrees Celsius to provide consistent protection to circuit conductors.

3. Circuit breakers with frame sizes greater than 100 ampere shall have variable magnetic trip elements, which are set by a single adjustment to simultaneously adjust the instantaneous trip point in all poles.

N. Equipment Ground Fault Module:

1. Circuit breakers 250A and less shall be equipped with a residual type ground module (GFM). The GFM shall be of solid state construction. The energy required to operate the circuit breaker ground fault tripping mechanism shall be derived from the ground fault current as a result of an output from the internal current sensor; no external power is required.

2. The GFM solid state circuitry shall provide branch circuit equipment ground fault protection by means of a compact module that mounts directly to the "OFF" end lugs of the circuit breaker. It is intended for use only on power systems that have a grounded conductor [neutral or grounded phase. The grounded conductor must be grounded at the service equipment but the neutral may or may not be used in the feeder or branch circuits as applicable.

3. Current settings for the grounded fault pick-up point shall be field adjustable from 20 through 100 amperes for 100 amperes ground fault modules and 40 through 200 amperes for 250 ampere ground fault modules. A switch shall be provided for setting the ground fault pick-up point.

4. The time delay of the GFM shall be field adjustable through 4 bands. The ground fault sensing circuitry shall have a built-in memory to sum the time increments if intermittent ground faults above the pick-up point. When the summation of time is equal to the preset time delay, the GFM will initiate a tripping signal to the breaker. If, however, an interval of greater than 5 minutes occurs where the fault current is not above the pick-up setting, the memory will reset and resume summing at 0. A sealable clear plastic cover shall prevent unauthorized adjustments to the pick-up and time delay settings. Provide an integral means of testing the ground fault system to meet the onsite testing requirements of NEC Article 230-95(c).

5. A neutral CT shall be provided with each GFM for application on 3 phase 4 wire systems.

6. The GFM will not affect the ampere interrupting ampacity of the circuit breaker.

7. The GFM shall be built in accordance with UL Standard 1053, Ground Fault Sensing and Relaying Equipment, and provide protection in accordance with NEC 110-10 and 230-95(c). It shall be listed under UL file E84625.

O. Terminations:

1. All lugs shall be UL listed to accept solid and/or stranded copper and aluminum conductors. Lugs shall be suitable for 75 degrees Celsius rated wire sizes 1/0 AWG and larger and 60 degrees Celsius rated wire sizes 14 AWG through 1 AWG.

2. All circuit breakers shall be UL listed to accept field installable/removable mechanical type lugs.

3. All circuit breakers shall be suitable for bus connection.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Install enclosed circuit breakers where indicated and in accordance with manufacturer's instructions.

B. Install enclosed circuit breakers plumb. Provide supports in accordance with Section 260529.

C. Height: 5 feet (1.6 Meters) to operating handle.

D. Provide engraved plastic nameplates under the provisions of Section 260553.

E. Contractor shall provide breaker locks on circuit breaker enclosures feeding emergency and normal/emergency circuits.

F. Provide circuit breaker in elevator machine room for each elevator controller. If elevator is equipped with an automatic lowering device, the elevator power circuit breaker shall be provided with an auxiliary contact that shall open when circuit breaker is in the open position. Shunt trip breaker for elevator power shall be provided with auxiliary contacts (one normally open, one normally closed) that shall open upon shut-down of power to the elevator. Coordinate with the fire alarm contractor and provide required wiring between shunt trip breaker and respective fire alarm equipment.

3.3 FIELD QUALITY CONTROL

A. Inspect and test each circuit breaker to NEMA AB 1.

B. Inspect each circuit breaker visually.

C. Perform several mechanical ON-OFF operations on each circuit breaker.

D. Verify circuit continuity on each pole in closed position.

3.4 ADJUSTING

A. Adjust trip settings so that circuit breakers coordinate with other over-current protective devices in circuit.

B. Adjust trip settings to provide adequate protection from over-current and fault currents.

3.5 APPLICATION

A. Circuit breaker enclosures used as switches in 120 volt and 277 volt florescent lighting circuits shall be listed and shall be marked SWD or HID. Circuit breaker enclosures used as switches in high intensity discharge lighting circuits shall be listed and shall be marked as HID.

B. Provide UL listed (UL489) circuit breaker enclosures for use with heating, air conditioning and refrigeration equipment compression multi-media or combination loads and marked “Listed HACR Type”. Where the equipment marking specifies fuses or “HACR Type” circuit breakers the circuit is intended to be protected only by the type of protection device specified.

END OF SECTION 26 28 17

SECTION 26 28 18 - MOLDED CASE CIRCUIT BREAKERS

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. Thermal Magnetic Molded Case Circuit Breakers: Furnish as specified herein and where shown on the associated drawing.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTALS

A. Provide outline drawings with dimensions, and ratings for voltage, amperage and maximum interruption. Include instructions for identification and receiving inspection, circuit breaker mounting, trip unit functions and adjustments, trouble shooting, accessories and wiring diagrams.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

1.4 QUALIFICATIONS

A. To be considered for approval, the Manufacturer shall furnish products listed by Underwriters Laboratories Incorporated (UL) or testing firm acceptable to the authority having jurisdiction as suitable for application specified.

B. The overcurrent protection device manufacturing facility shall be registered by Underwriters Laboratories Incorporated to the International Organization for Standardization ISO 9000 Series Standards for quality.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D.

B. General Electric.

C. EATON/Cutler Hammer.

2.2 MOLDED CASE CIRCUIT BREAKERS

A. Molded Case Circuit Breaker Characteristics - General:

1. 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.

2. Circuit breakers shall have an over center, trip free, toggle operating mechanism which will provide quick-make, quick-break contact action. The circuit breaker shall have common tripping of all poles.

3. The circuit breaker handle shall 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.

4. The maximum ampere rating and UL, IEC or other certification standards with applicable voltage systems and corresponding interruption ratings shall be clearly marked on face of circuit breaker.

5. Each circuit breaker shall be equipped with a push-to-trip button, located on the face of circuit breaker to mechanically operate the circuit breaker tripping mechanism for maintenance and testing purposes.

6. Circuit breakers shall be factory sealed with a hologram quality mark and shall have date code on face of circuit breaker.

7. Manufacturer shall provide electronic and hard copy time/current characteristic trip curves (and Ip and I^2t let through curves for current limiting circuit breakers) for each type of circuit breaker.

8. Circuit breakers shall be equipped with UL listed electrical accessories as noted on the associated schedule or drawing. Circuit breaker handle accessories shall provide provisions for locking handle in the ON and OFF position.

9. All circuit breakers shall be UL listed for reverse connection without restrictive line and load markings and be suitable for mounting in any position.

10. Circuit breakers shall be fixed construction with factory installed mechanical lugs. All circuit breakers shall be UL listed to accept field installable/removable mechanical type lugs. Lug body shall be bolted in place; snap in design not acceptable. All lugs shall be UL listed to accept solid (not large than number 8 AWG) and/or stranded copper conductors only. Lugs shall be suitable for 60 degrees Celsius rated wire sizes 14 AWG through 1 AWG and 75 degrees Celsius rated wire sizes 1/0 AWG and larger.

11. All circuit breakers shall be capable of accepting bus connections.

B. Thermal-Magnetic Circuit breakers:

1. Circuit breakers shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole.

2. Thermal trip elements shall be factory preset and sealed. Circuit breakers shall be true RMS sensing and thermally responsive to protect circuit conductor(s) in a 40 degrees Celsius ambient temperature.

3. Circuit breaker frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker.

4. Standard 2 and 3 pole circuit breakers up to 250 amperes at 600 VAC shall be UL listed as HACR type.

C. Equipment Ground Fault Protection (Thermal Magnetic Circuit Breakers)

1. Ground fault sensing system shall be modified zero sequence sensing type.

2. The grounding fault system shall require no external power to trip the circuit breaker.

3. Companion circuit breaker shall be equipped with a ground fault shunt trip.

4. The ground fault sensing system shall be suitable for use on grounded systems. The ground fault sensing system shall be suitable for use on 3 phase, 3 wire circuits where the system neutral is grounded but not carried through the system or on 3 phase, 4 wire systems.

5. Ground fault pickup current setting and time delay shall be field adjustable. A switch shall be provided for setting ground fault pickup point. A means to seal the pickup and delay adjustments shall be provided.

6. The ground fault sensing system shall include a ground fault memory circuit to sum the time increments of intermittent arcing ground faults above the pickup point.

7. A means of testing the ground fault system to meet the onsite testing requirements of NEC Section 230-95(C) shall be provided.

8. Local visual ground fault trip indication shall be provided.

9. The ground fault sensing system shall be provided with Zone Selective Interlocking (ZSI) communication capabilities compatible with other thermal magnetic circuit breakers equipped with ground fault sensing, electronic trip circuit breakers with integral ground fault sensing and external ground fault sensing as noted on schedules or drawings.

10. The companion circuit breaker shall be capable of being group mounted.

11. The ground fault sensing system shall not affect interrupting rating of the companion circuit breaker.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Install circuit breakers in accordance with Manufacturer's instructions, the national Electrical Code and applicable local codes.

3.3 ADJUSTING

A. Circuit breaker pickup level and time delay settings shall be adjusted to values indicated in the coordination study provided by the testing company.

END OF SECTION 26 28 18

SECTION 26 29 13 - ENCLOSED 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. This Section includes the following:

1. Manual motor controllers.

2. Combination magnetic motor controllers (disconnect switch type).

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTALS

A. Submit under provisions of Section 260500.

B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and over-current protective devices, short circuit ratings, dimensions and enclosure details.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

D. Test Reports: Indicate field test and inspection procedures and test results.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation and starting of Product.

F. 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.

1.4 QUALTIY ASSURANCE

A. Perform work in accordance with NECA Standard of Installation.

B. Comply with NFPA 70.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum five years experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D Company.

B. General Electric.

C. EATON/Cutler Hammer

2.2 MANUAL MOTOR CONTROLLER (THERMAL SWITCH)

A. Description: NEMA ICS 2, AC general purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit. Where indicated on the drawings, provide red pilot light.

B. Enclosure: ANSI/NEMA ICS 6, Type as indicated.

2.3 DISCONNECT SWITCH TYPE COMBINATION MAGNETIC MOTOR CONTROLLERS (NON-REVERSING)

A. Description: Combination magnetic motor controllers with non-fusible disconnect switch in common enclosure. Switch shall have a color-coded externally operated handle. Operating handle shall give positive visual indication of ON-OFF with red and black color-coding.

1. Non-fusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle and visible blades. Operating handle shall give positive visual indication of ON-OFF with a color-coded operating handle.

B. Magnetic Motor Controllers: NEMA ICS 2, AC general purpose Class A magnetic controller for induction motors rated in horsepower.

C. Coil Operating Voltage: 120/277 volts (as required by feeder), 60 Hz.

D. Coil: Be of encapsulated type.

E. Poles: Three.

F. Size: As indicated.

G. Contacts: Totally enclosed, double-break, silver-cadmium-oxide contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring.

H. Wiring: Straight-through wiring with all terminals clearly marked.

I. Overload Relay: NEMA ICS; melting alloy with 1 piece thermal unit construction. Thermal units shall be interchangeable. Overload relay control circuit contact shall be replaceable. Thermal units shall be required for starter to operate.

J. Enclosure: ANSI/NEMA ICS 6, Type as indicated.

K. Accessories:

1. Auxiliary Contacts: NEMA ICS 2, 2 each normally open, closed, field convertible contacts in addition to seal-in contact.

2. Cover Mounted Pilot Devices: NEMA ICS 2, heavy duty type.

3. Pilot Device Contacts: NEMA ICS 2, Form Z, rated A150

4. Push Buttons: Recessed type.

5. Indicating Lights: LED type.

6. Selector Switches: Rotary type, H-O-A.

7. Relays: NEMA ICS 2.

8. Control Power Transformers: 120 volt secondary, 500 VA minimum, in each motor starter. Provide fused primary and secondary and bond unfused leg of secondary to enclosure.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Install enclosed controllers where indicated in accordance with Manufacturer's instructions.

B. Install enclosed controllers plumb. Provide supports in accordance with Section 260529.

C. Mounting Height: as indicated on drawings to operating handle.

D. Select and install overload heater elements in motor controllers to match installed motor characteristics.

E. Provide engraved plastic nameplates under the provisions of Section 260553.

F. Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor and voltage/phase rating.

3.3 FIELD QUALITY CONTROL

A. Inspect and test each enclosed controller to NEMA ICS 2.

3.4 DELIVERY, STORAGE AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances and physical damage.

B. If stored in areas subjected to weather, cover enclosed controllers to protect from weather, dirt, dust, corrosive substances and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

3.5 APPLICATION

A. Provide UL listed (UL 489) circuit breakers for use with heating, air-conditioning and refrigeration equipment comprising multimedia or combination loads are marked “Listed HACR Type”. Where the equipment marking specifies fuses, or HACR Type circuit breakers, the circuit is intended to be protected only by the type of protective device specified.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit breaker trip ranges.

3.7 STARTUP SERVICE

A. Engage a factory authorized service representative to perform startup service.

B. Verify that enclosed controllers are installed and connected according to the Contract Documents.

3.8 DEMONSTRATION

A. Engage a factory authorized service representative to train Owner’s maintenance personnel to adjust, operate and maintain enclosed controllers. Allow 4 hours for Owner’s training.

END OF SECTION 26 29 13

SECTION 26 29 30 - EQUIPMENT WIRING 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:

1. Electrical connections to equipment specified under other Divisions.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 COORDINATION

A. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other Divisions.

B. Determine connection locations and requirements.

C. Sequence rough in of electrical connections to coordinate with installation schedule for equipment.

D. Sequence electrical connections to coordinate with start-up schedule for equipment.

E. Division 26 Contractor shall provide required 120 volt circuits for HVAC controls, fire alarm systems, etc. Coordinate with Division 25 Contractor for specific requirements.

PART 2 - PRODUCTS

2.1 CORDS AND CAPS

A. Attachment Plug Configuration: Match receptacle configuration at outlet provided for equipment.

B. Cord Construction: Oil-resistant thermoset insulated Type SO multi-conductor flexible cord with identified equipment grounding conductor, suitable for hard usage in damp locations.

C. Cord Size: Same as rating of branch circuit over-current protection.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 PREPARATION

A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

3.3 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.4 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.

C. Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.

D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is required.

E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

F. Install combination starters, disconnect switches, controllers, control stations, and control devices as indicated.

G. Verify proper rotation of three-phase equipment.

H. Extend power wiring, where applicable, through external disconnect switches, combination starter/disconnect switches, thermal switches, local control switches, remote mounted control panels, etc. and connect to terminals in the equipment.

I. Where applicable, extend wire and conduit between control device (start/stop pushbuttons or lighted handle switch) and combination starter/disconnect switches.

J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

3.5 CONTRACTOR RESPONSIBILITIES (MECHANICAL CONTRACT)

A. Cabinet Unit Heaters (Electric):

1. 277 volt, 1 phase.

2. Fused disconnect switch in unit by equipment Manufacturer.

3. Division 25 Contractor shall provide any other connections and/or equipment required.

B. Horizontal Unit Heaters (Propeller Type) (Electric):

1. 277 volt, 1 phase.

2. Fused disconnect switch in unit by equipment Manufacturer.

3. Division 25 Contractor shall provide any other connections and/or equipment required.

C. Indoor Fans - ATC Controlled:

1. 120 volt, 1 phase.

2. Thermal overload switch shall be furnished and installed adjacent to the fan by Division 26 Contractor.

3. Any other connections and/or equipment required shall be provided by Division 25 Contractor.

D. Indoor Fans - ATC Controlled:

1. 208 volt, 3 phase.

2. Combination starter/disconnect switch shall be furnished and installed by Division 26 Contractor.

3. Any other connections and/or equipment required shall be provided by Division 25 Contractor.

E. Roof Fans - Manually Controlled:

1. 120 volt, 1 phase.

2. Integral disconnect switch provided by the equipment Manufacturer.

3. Thermal overload switch (with pilot light) furnished and installed by Division 26 Contractor.

4. Where indicated, light switches, or lighted handle toggle switches shall control fans. In these cases, thermal overload switches shall be furnished and installed by Division 26 Contractor where indicated on the plans.

F. Roof Fans - Manually Controlled:

1. 208 volt, 3 phase.

2. Integral disconnect switch provided by equipment Manufacturer.

3. Remote combination starter/disconnect switch shall be furnished and installed by Division 26 Contractor.

G. Dedicated Outdoor Air System Units (Indoor) (Outdoor):

1. 480 volt, 3 phase.

2. Division 26 contractor shall provide a single point power connection.

3. All wiring from the input terminals to the respective devices in the unit shall be factory installed by the equipment Manufacturer.

4. Variable frequency drive units shall be furnished and installed by Division 25 Contractor.

5. Any other connections and/or equipment required shall be provided by Division 25 Contractor.

H. Roof Top Unit (Outdoor):

1. 480 volt, 3 phase.

2. Division 26 contractor shall provide a single point power connection.

3. Starters with overload protection shall be furnished and installed by equipment Manufacturer.

4. All wiring to the respective devices in the unit shall be factory installed by the equipment Manufacturer.

5. Control transformers with weatherproof enclosure shall be provided and wired by Division 25 Contractor.

I. Ductless Mini-Split Heating/Cooling System (Split System):

1. 208 volt, 1 or 3 phase

2. Fused Safety switch or 2-pole toggle switch to be furnished and installed adjacent to the unit by Division 26 Contractor.

3. Control transformers shall be furnished and installed by Division 25 Contractor.

4. Division 25 Contractor shall provide integral condensate pump, including all power and control wiring.

J. Outdoor Condensing Units for Ductless Mini-Split Heating/Cooling System (Split System):

1. 208 volt, 1 or phase

2. Starters with overload protection shall be furnished and installed by equipment Manufacturer.

3. Division 26 Contractor shall furnish and install a fused weatherproof disconnect switch.

4. All wiring to the respective devices in the unit shall be factory installed by the equipment Manufacturer.

5. Control transformers with weatherproof enclosure shall be furnished and installed by Division 25 Contractor.

K. Electric Baseboard [Line Voltage Control]:

1. 277 volt, 1 phase.

2. Division 26 contractor shall provide a single point power connection.

3. Division 25 Contractor shall furnish and install in-line thermostats and these thermostats shall include positive "off" position.

4. All interconnections between individual sections of electric baseboard units shall be by Division 25 Contractor.

L. Ceiling Mounted Unit Heaters:

1. 277 volt, 1 phase.

2. Fused disconnect switch in unit by equipment Manufacturer.

3. Division 25 Contractor shall provide any other connections and/or equipment required.

M. Pumps:

1. 120 volt, single phase.

2. Thermal overload switch shall be furnished and installed by Division 26 Contractor. Division 26 contractor install switch adjacent to the unit.

N. Pumps:

1. 208 & 480 volt, 3 phase.

2. Combination starter/disconnect switch with overload protection shall furnished and installed by Division 26 Contractor.

3. Variable frequency drive units shall be furnished by Division 25 Contractor.

O. Kitchen Hood Supply and Exhaust Fans Manual Control (Packaged Unit):

1. 208 volt, 3 phase.

2. An integral factory wired control panel shall be provided by the Manufacturer. Control panel shall include all starters, overload protection, disconnects, fuses, control transformer and terminal strips.

3. Division 26 Contractor shall extend power wiring to unit control panel and make 1 power connection.

4. Division 25 Contractor shall furnish remote control switches.

5. Division 26 Contractor shall install switches and extend conduit and conductors to hood lights and to the control panel for fan control.

P. Heat Pump Units:

1. 277 volt, 1 phase or 480 volt, 3 phase.

2. Division 26 Contractor shall provide fused disconnect or thermal overload switch, mounted on or adjacent to unit, and make final connection to unit.

3. All other wiring within the unit shall be by Division 25 Contractor.

4. Integral control transformer shall be provided by the equipment Manufacturer.

3.6 CONTRACTOR RESPONSIBILITIES (PLUMBING CONTRACT)

A. Domestic Water Heat Pump Units:

1. 480 volt, 3 phase.

2. Division 26 Contractor shall provide fused disconnect, mounted on or adjacent to unit, and make final connection to unit.

3. All other wiring within the unit shall be by Division 25 Contractor.

4. Integral control transformer shall be provided by the equipment Manufacturer.

B. Water Heater Package Storage Type:

1. 208 or 480 volt, 3 phase

2. Integral factory wired control panel shall be provided by the Manufacturer. Control panel shall include all starters, overload protection, disconnects, fuses and control transformer.

3. Division 26 Contractor shall extend power wiring to the control panel and make 1 power connection.

C. Sump Pump:

1. 120 volt, single phase.

2. The Manufacturer shall provide cord and plug.

3. Division 26 Contractor shall furnish and install a receptacle adjacent to unit and connect.

D. Sump Pump Duplex Submersible:

1. 120 volt, single phase.

2. Built-in thermal overload protection shall be provided in the motors by the Manufacturers.

3. A remote mounted automatic alternator control panel and a remote mounted high water alarm panel shall be furnished and installed by the Division 25 Contractor.

4. Division 26 Contractor shall extend power wiring to the control panel and make 1 power connection to each control panel.

5. All other control wiring shall be by the Division 25 Contractor.

3.7 CONTRACTOR RESPONSIBILITIES (GENERAL CONTRACT)

A. Laboratory and Science Equipment:

1. The General Contractor shall furnish, install and set in place laboratory and science equipment. Roughing-in of all electrical services shall be by the Division 26 Contractor from an approved rough-in shop drawing obtained from the General Contractor.

2. Division 26 Contractor shall provide electrical service connections and outlet boxes in or at the equipment, or stub up from floor or out of walls, or stub down from ceilings and make final connections to the equipment as required.

3. Where laboratory equipment is provided by the General Contractor and is furnished complete with devices and pre-wired, Division 26 Contractor shall make the final power connections to equipment.

4. Where laboratory equipment is provided by the General Contractor and is furnished with loose devices, Division 26 Contractor shall install the devices, wire, and make final power connections to the equipment.

B. Casework:

1. All casework included with the General Contract will include all necessary electrical devices, disconnect switches, starters, thermal switches and special control devices. Such electrical items will be delivered to the Electrical Contractor for installation and wiring.

2. Division 26 Contractor shall furnish and install all necessary inter-connecting wiring within the casework and shall make final connections to the building service system. The exact locations for wiring connections will be determined by the casework supplier and will be furnished by the General Contractor to the Division 26 Contractor.

3. Fume hoods and exhaust booths will be provided and installed under the General Contract, complete with exhaust fans and motors, and will be completely pre-wired, ready for final connection by the Division 26 Contractor.

C. Elevator:

1. Provide all power connections as indicated on contract documents to final connection on elevator machine equipment. All power and control wiring from elevator control to elevator and any associated devices are by the elevator manufacturer/installer.

2. For elevators supplied by normal/emergency power source, provide necessary control wiring between elevator controller and associated automatic/manual transfer equipment in emergency power system for emergency power (generator) connection.

3. Provide all control wiring necessary between elevator shunt trip breaker NO or NC contacts and elevator controller/fire alarm system to ensure proper system operation, as coordinated with elevator installer and fire alarm system installer.

3.8 CONTRACTOR RESPONSIBILITIES (GENERAL CONTRACT AND/OR OWNER PROVIDED)

A. Unless noted otherwise, lighting fixtures and lamps within hoods shall be furnished and installed by the hood manufacturer. Division 26 Contractor shall furnish and install switches and wiring as required.

3.9 CONTRACTOR RESPONSIBILITIES (FOOD SERVICE CONTRACT)

A. Kitchen Equipment:

1. Provide a circuit for each piece of electrically operated equipment in the kitchen and the dishwashing rooms. Circuits shall terminate in a receptacle, a switch or arranged for direct connection to equipment, or as indicated on the drawings. Final power connections to each piece of electrically operated equipment shall be made by Division 26 Contractor. Division 26 Contractor shall secure roughing-in shop drawings from the food service equipment contractor, and all equipment outlets shall be installed at locations shown on shop drawings regardless of where shown on contract drawings.

2. Kitchen hood shall include all overcurrent protection, conduit, wiring, final connections and/or utilization devices for all equipment to be utilized under the hood. Division 26 contractor shall provide multiple single point power connections to kitchen hood at

different utilization voltages. All other internal wiring and final connections to equipment are by food service equipment contractor.

3. Unless noted otherwise, lighting fixtures and lamps within hoods shall be furnished and installed by the hood Manufacturer. Division 26 Contractor shall furnish and install switches and wiring as required.

B. Food Service Equipment:

1. The food service equipment will be furnished and installed under the Food Service Equipment Contract, but the Division 26 Contractor will provide all related electrical work. Necessary disconnect switches, starters, thermal switches, and special control devices will be provided by the Food Service Equipment Contractor and delivered to the Division 26 Contractor for installation and wiring. Division 26 Contractor shall install all necessary inter-connecting wiring within the equipment.

2. Division 26 Contractor is required to bring his service where required to make final connections. The Food Service Equipment Contractor will determine the exact locations for such and that information will be furnished to the Division 26 Contractor.

3. Installation of fractional horsepower equipment shall be made by installing a duplex outlet, 3-wire grounding type in wall behind the machine, except where floor outlets are indicated, and making final connection through a 3-wire cap with cord grip. Each machine shall be provided with approved grounding. Flexible feeders from junction boxes shall be provided as required.

4. Interlock wiring for condensing units, evaporative blower units, and lighting in walk-in cooler/freezer units shall be provided by the Electrical Contractor.

5. All work shall be installed in accordance with the standards and requirements of the NSF, DER, and NEC.

END OF SECTION 26 29 30

SECTION 26 32 13 - PACKAGED ENGINE GENERATOR 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:

1. Packaged engine generator system.

2. Sub-base fuel tank and fittings and accessories

3. Exhaust silencer and fittings.

4. Battery and charger.

5. Remote control panel.

6. Weatherproof enclosure.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTALS

A. Submit under provisions of Section 260500.

B. Shop Drawings: Indicate electrical characteristics and connection requirements. Show plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, electrical diagrams including schematic and interconnection diagrams.

C. Product Data: Provide data showing dimensions, weights, ratings, interconnection points and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators.

D. Test Reports: Indicate results of performance testing.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation and starting of product.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

G. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 260500.

B. Operation Data: Include instructions for normal operation.

C. Maintenance Data: Include instructions for routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear and emergency maintenance procedures.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with NFPA 110.

B. Comply with NEC Articles 695, 700, 701, 702 and 705.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years experience and with service facilities within 100 miles of the project.

B. Supplier: Authorized distributor of specified manufacturer with minimum three years experience.

1.7 MAINTENANCE MATERIALS

A. Furnish one set of tools required for preventative maintenance of the engine generator system. Package tools in adequately sized metal toolbox.

1.8 EXTRA MATERIALS

A. Provide two of every fuse, indicator lamps used.

B. Provide two of each fuse, oil and air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Kohler Company.

B. Cummins

C. Caterpillar, Inc.

D. MTU.

E. Generac

2.2 PACKAGE ENGINE GENERATOR SYSTEM

A. Level 1 applications are legally required emergency systems (NEC, Article 700.1)

B. Level 2 applications are standby systems (NEC, Article 701.2).

C. Description: NFPA 110, engine generator system to provide source of power for Level 1 and 2 applications.

D. System Capacity: 150 kW, 187.5 kVA at elevation of 500 feet above sea level, standby rating using engine-mounted radiator.

2.3 ENGINE

A. Type: Water-cooled inline or V-type, four stroke cycle, compression ignition Diesel internal combustion engine.

B. Prime Rating: Sufficient to operate under 10 percent overload for one hour in an ambient of 90 degrees Fahrenheit 32 degrees Celsius at elevation of 500 feet.

C. Fuel System: Diesel.

D. Engine Speed: 1800 rpm.

E. Governor: To maintain engine speed within 0.5 percent, steady state and 5 percent no load to full load with recovery to steady state within two seconds following sudden load changes. Equip governor with means for manual operation and adjustment.

F. Safety Devices: Engine shutdown on high water temperature, low oil pressure, over speed, engine over crank and low coolant level. Limits as selected by manufacturer.

G. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.

H. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees Fahrenheit (32 degrees Celsius) and suitable for operation on 208 volts AC.

I. Radiator: Radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110 degrees Fahrenheit (43 degrees Celsius). Radiator air flow restriction 0.5 inches of water (1.25 PA) maximum.

J. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, gear-driven water pump, fuel transfer pump, fuel priming pump. Include fuel pressure gauge, water temperature gauge and lube oil pressure gauge on engine/generator control panel.

K. Mounting: Provide unit with suitable spring-type vibration isolators and mount on structural steel base.

L. Comply with NFPA 37.

2.4 GENERATOR

A. Generator: NEMA MG 1, three phase, four pole, reconnectable brushless synchronous generator with brushless exciter.

B. Rating: 150 kW, 187.5 kVA, at 0.8 power factor, 480Y/277 volts, 60 Hz at 1800 rpm.

C. Insulation: Class H.

D. Temperature Rise: 130 degrees Celsius standby.

E. Enclosure: NEMA MG 1, open drip proof.

F. Voltage Regulation: Include generator-mounted volts per hertz exciter-regulator to match engine and generator characteristics, with voltage regulation plus or minus 1 percent from no load to full load. Include manual controls to adjust voltage drop, (plus or minus 5 percent) and voltage gain.

2.5 ACCESSORIES

A. Skid-Mounted Fuel Tank: Steel tank with fill and vent, minimum capacity 12 hours at full load. 660 gallon steel tank maximum size allowable by NFPA 31

B. Exhaust Silencer: Critical type silencer with muffler companion flanges and flexible stainless steel exhaust fitting sized in accordance with engine manufacturer's instructions.

C. Batteries: Heavy duty, lead-calcium storage batteries. Capacity shall be as recommended by manufacturer for the specified application level. Match battery voltage to starting system. Include necessary cables and clamps. Provide anti-corrosion seals on terminal posts.

D. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.

E. Battery Charger: Current limiting type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter and 120 volts AC fused input. Provide wall-mounted enclosure to meet ANSI/NEMA 250, Type 1 requirements.

F. Flexible Oil Drain Extension: When uncoiled, capable of extending 6 inches beyond pad edge. Provide petcock with flexible oil drain extension.

G. Dual Line Circuit Breakers: NEMA AB 1 molded case circuit breaker on generator output with integral electronic trip unit as specified in Section 262818. Size as indicated on drawings. Include battery-voltage operated shunt trip, connected to open circuit breaker on engine failure. Mount unit in enclosure to meet NEMA 250, Type 1 requirements on generator.

H. Engine-Generator Control Panel: NEMA 250, Type 1, generator mounted control panel enclosure with engine and generator controls and indicators. Include the following equipment and features:

1. Frequency Meter: 45-65 Hz range, 3.5 inch dial.

2. AC Output Voltmeter: 3.5 inch dial., 2 percent accuracy with phase selector switch.

3. AC Output Ammeter: 3.5 inch dial., 2 percent accuracy with phase selector switch.

4. Output Voltage Adjustment.

5. Push-to-Test Indicator Lamps: One each for low oil pressure, high water temperature, over speed and over crank.

6. Engine Start/Stop Selector Switch.

7. Engine Running Time Meter.

8. Oil Pressure Gauge.

9. Water Temperature Gauge.

10. Low Oil Pressure Pre-alarm - Audio and Visual.

11. High Water Temperature Pre-alarm - Audio and Visual.

12. Leak Detection – Audio and visual.

13. Alarm Relay and Horn with Silence Switch.

14. Auxiliary Relay: 3PDT, operates when engine runs with contact terminals pre-wired to terminal strip.

15. Remote Alarm Contacts: Pre-wire SPDT contacts to terminal strip for remote alarm functions required by NFPA 110.

I. Remote Annunciator Panel: Surface mounted panel with painted finish. Provide audible and visible indicators as required by NFPA 110 and as follows:

1. High battery voltage (alarm).

2. Low battery voltage (alarm).

3. Low fuel (alarm).

4. System ready.

5. Anticipatory high water temperature.

6. Anticipatory low oil pressure.

7. Low coolant temperature.

8. Switch in off position (alarm).

9. Over crank (alarm).

10. Emergency stop (alarm).

11. High water temperature (alarm).

12. Over speed (alarm).

13. Low oil pressure (alarm).

14. Leak detection (alarm).

15. Line power available.

16. Generator power available.

17. Lamp test and horn silence switch.

J. Sound Attenuated Weather Protective Enclosure: Reinforced steel housing allowing access to control panel and service points with lockable doors and panels. Include fixed louvers, fuel tank, battery rack and silencer. The housing shall provide 25 dB of attenuation

K. Vibration Isolators: Spring type with neoprene pads.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Mount on vibration isolators.

C. Permanently connect battery charger cables to batteries.

D. Fill fuel tank after completion of all load and acceptance testing, prior to turning over to owner.

E. Clean all fuel system components prior to installation and initial start-up.

F. Contractor shall provide all conduit, wiring and connections to control panel to ATS and remote annunciator as required by manufacturer's requirements and/or recommendations; provide engine start circuit, battery charger circuit, battery heater circuit, engine jacket heater circuit and all control circuits for a complete and operational system.

G. Engine-generator control panel shall be mounted on the generator in a location that allows maintenance personnel to observe them readily without changing position from a logical maintenance work position at the generator.

H. Contractor shall provide control panel for generator with sub-base tank no higher than 6'-0" AFF. If standard control panel is more than 6'-0" AFF, contractor shall provide remote control panel with all required controllers/indicators at a location less than 6'-0" AFF.

I. Utility or City water supply service shall not be used for generator water cooled systems.

3.3 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 260574.

B. Provide full load test utilizing portable test bank, if required, for 4 hours minimum. Simulate power failure including operation of transfer switch, automatic starting cycle, automatic shutdown and return to normal.

C. Record in 20 minute intervals during the first 4 hour test:

1. Kilowatts.

2. Amperes.

3. Voltage.

4. Coolant temperature.

5. Room temperature.

6. Frequency.

7. Oil pressure.

D. Test alarm and shutdown circuits by simulating conditions.

3.4 MAINTENANCE AND SERVICE AGREEMENT

A. Manufacturer shall provide maintenance and service for the engine generator systems for a period of 3 years after the date of final acceptance. Maintenance agreement shall include the following services:

1. Off hours operational test under building/plant load to verify system operation.

2. Check fluid levels.

3. Change oil and filter twice yearly.

3.5 ADJUSTING

A. Adjust operating mechanisms for free mechanical movement. Calibrate motors and instrumentation to the accuracy specified or required for proper operation.

B. Adjust generator output voltage and engine speed.

3.6 CLEANING

A. Clean engine and generator surfaces. Replace oil and fuel filters.

3.7 DEMONSTRATION

A. Provide systems demonstration under provisions of Section 260500. Describe loads connected to emergency and standby system and restrictions for future load additions.

B. Simulate power outage by interrupting normal source and demonstrate that system operates to provide emergency and standby power.

C. Instruction shall be provided by factory trained representative(s) of the system supplier. Allow 4 hours for Owner instruction.

D. The manufacturer shall provide written certification that the engine generator system are complete and operating in accordance with all warranty requirements.

3.8 PERFORMANCE

A. The generator shall be capable of starting and achieving rated voltage and frequency within 10 seconds following the closing of the contact in the cranking circuit.

3.9 WARRANTY

A. Manufacturer shall provide written warranty covering all equipment furnished under this section. Warranty shall cover all defects in materials and/or workmanship for a period of 2 year from date of final acceptance of equipment by the Owner and shall include all costs of parts, labor, travel and living expenses for the manufacturer's service representative. The manufacturer shall respond to all requests for warranty service within 4 hours.

3.10 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site in protective wrappings, containers and other protection that will exclude dent and moisture and prevent damage from construction operations.

B. Accept unit on site on skids. Inspect for damage.

END OF SECTION 26 32 13

SECTION 26 36 00 - AUTOMATIC TRANSFER SWITCH

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. Automatic transfer switch.

2. Non-Automatic transfer switch.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTALS

A. Submit under provisions of Section 260500.

B. Product Data: Provide catalog sheet showing voltage, switch size, ratings and size of switching and over-current protective devices, operating logic, short circuit ratings, dimensions and enclosure details.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 260500.

B. Operation Data: Include instructions for operating equipment. Include instructions for operating equipment under emergency conditions when engine generator is running.

C. Maintenance Data: Include routine preventative maintenance and lubrication schedule. List special tools, maintenance materials and replacement parts.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum five years experience and with service facilities within 100 miles of Project.

1.6 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings.

1.7 MAINTENANCE SERVICE

A. Furnish service and maintenance of transfer switch for one year from Date of Substantial Completion.

1.8 MAINTENANCE MATERIALS

A. Provide maintenance materials under provisions of Section 260500.

B. Provide two of each special tool required for maintenance.

1.9 QUALITY ASSURANCE

A. Comply with NEMA ICS 1.

B. Comply with NFPA 70.

C. Comply with NFPA 99.

D. Comply with NFPA 110.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Kohler.

B. Cummins.

C. Caterpillar, Inc.

D. Generac.

E. MTU.

F. Russelectric, Inc.

G. Emerson/Automatic Switch Company.

H. Zenith Controls, Inc.

2.2 AUTOMATIC TRANSFER SWITCH

A. Description: NEMA ICS 2, automatic transfer switch.

B. Configuration: Electrically operated, mechanically held transfer switch.

2.3 NON-AUTOMATIC TRANSFER SWITCH

A. Operation: Switch is capable of transferring load in either direction with either or both sources energized.

B. Double-throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.

2.4 RATINGS

A. Voltage: 277/480 volts, three phase, four wire, 60Hz.

B. Switched Poles: Four.

C. Load Inrush Rating: Resistive load.

D. Continuous Rating: As indicated on drawings.

E. Withstand Current Rating: 22,000 RMS symmetrical amperes when used with molded case circuit breaker.

2.5 PRODUCT ACCESSORIES

A. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, SWITCH POSITION.

B. Test Switch: Mount in cover of enclosure to simulate failure of normal source.

C. Transfer Switch Auxiliary Contacts: 1 normally open; 1 normally closed.

D. Normal Source Monitor: Monitor each line of normal source voltage and frequency, initiate transfer when voltage drops below 85 percent or frequency varies more than 4 percent from rated nominal value; initiate re-transfer to normal when at least 90 percent of normal voltage is available.

E. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 80 percent or frequency varies more than 4 percent from rated nominal value.

F. In-Phase Monitor: Inhibit transfer until source and load are within 70 percent of rated voltage and frequency.

G. Switched Neutral: Non-overlapping contacts.

H. Insulated neutral plate.

I. Terminal provisions for connection of area protection panel.

2.6 AUTOMATIC SEQUENCE OF OPERATION

A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.

B. Time Delay to Start Alternate Source Engine Generator: 0 to 60 seconds, adjustable. Set at 1 second.

C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.

D. Time Delay Before Transfer to Alternate Power Source: 0 to 60 seconds, adjustable. Set at 1 second.

E. Initiate Re-transfer Load to Normal Source: Upon permission by normal source monitor.

F. Time Delay Before Transfer to Normal Power: 1 to 30 minutes, adjustable; bypass time delay in event of alternate source failure. Set at 5 minutes.

G. Time Delay Before Engine Shut Down: 1 to 30 minutes, adjustable of unloaded operation. Set per Manufacturer’s recommendation.

H. Engine Exerciser: Start engine every 7 days; run for 30 minutes before shutting down. Bypass exerciser control if normal source fails during exercising period.

2.7 ENCLOSURE

A. Enclosure: NEMA 1, suitable for wall mounting.

B. Finish: Manufacturer's standard enamel.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Verify that surface is suitable for transfer switch installation.

3.3 INSTALLATION

A. Install transfer switches in accordance with Manufacturer's instructions.

B. Extend control wiring from alternate source through normally open contacts of voltage sensing relay monitoring alternate source; to operate coil of integral contactor.

C. Provide engraved plastic nameplates under provisions of Section 260553.

3.4 APPLICATION

A. Four Pole Switches: Where four pole switches are indicated, install neutral switching.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate and maintain transfer switches and related equipment as specified below:

1. Coordinate this training with that for generator equipment.

2. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing and maintaining equipment.

3. Schedule training with Owner; with at least seven days advance notice.

4. Provide a minimum of four hours of instruction.

3.6 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt and debris. Repair damaged finish to match original finish.

B. Clean equipment internally, on completion of installation, according to Manufacturer's written instructions.

3.7 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 260500.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris and traffic.

C. Handle in accordance with Manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to internal components, enclosure and finish.

3.8 FIELD QUALITY CONTROL

A. Testing: Test transfer switch products by operating them all in modes. Perform tests recommended by Manufacturer under the supervision of Manufacturer's factory-authorized service representative. Correct deficiencies and report results in writing. Record adjustable relay settings.

B. Testing: Perform the following field quality control testing under the supervision of the Manufacturer's factory-authorized service representative in addition to tests recommended by the Manufacturer.

1. Before energizing equipment, after transfer switch products have been installed:
   a. Measure insulation resistance phase-to-phase and phase-to-ground with insulation resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by Manufacturer. Meet Manufacturer's specified minimum resistance.
   b. Check for electrical continuity of circuits and for short circuits.
   c. Inspect for physical damage; proper installation and connection and integrity of barriers, covers and safety features.
   d. Verify that manual transfer warnings are properly placed.
   e. Perform manual transfer operation.

2. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for phase of normal source.
   c. Verify time delay settings.

d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Perform contact resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power and engine cool-down and shutdown sequence.

END OF SECTION 26 36 00

SECTION 26 41 13 - LIGHTNING PROTECTION 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:

1. Design and installation of lightning protection system.

2. Air terminals and interconnecting conductors.

3. Grounding and bonding for lightning protection.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SYSTEM DESCRIPTION

A. Lightning Protection System:

1. ANSI/NFPA 780.

2. Class 1 UL 96A.

B. Master labeled system protecting entire facility, consisting of, but not limited to, air terminals on roofs, roof-mounted mechanical equipment, chimneys and stacks and penthouse roofs; bonding of structure and other metal objects; grounding electrodes and interconnecting conductors.

1.4 SUBMITTALS FOR REVIEW

A. Submit under provisions of Section 260500.

B. Shop Drawings: Indicate layout of air terminals, grounding electrodes and bonding connections to structure and other metal objects. Include terminal, electrode and conductor sizes and connection and termination details.

C. Product Data: Provide dimensions and materials of each component and include indication of listing in accordance with UL 96.

D. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

1.5 SUBMITTALS FOR INFORMATION

A. Manufacturer's Certificate:

1. Certify that products meet or exceed specified requirements.

2. Submit certificate of compliance from Underwriter's Laboratories, Inc. indicating approval of lightning protection systems.

1.6 PROJECT CLOSEOUT SUBMITTALS

A. Record actual locations of air terminals, grounding electrodes, bonding connections and routing of system conductors in project record documents.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 780.

B. Perform Work in accordance with UL 96A and provide Master Label.

C. Perform Work in accordance with LPI-175.

D. Perform Work in accordance with LPI-176.

E. Maintain 1 copy of document onsite.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in lightning protection equipment with minimum 5 years documented experience and member of the Lightning Protection Institute.

B. Installer: Authorized installer of Manufacturer with minimum 5 years documented experience and certified by the Lightning Protection Institute.

1.9 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings.

1.10 COORDINATION

A. Coordinate work with roofing and exterior and interior finish installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Heary Brothers.

B. Harger Lightning Protection, Inc.

C. Thompson Lightning Protection, Inc.

2.2 COMPONENTS

A. Air Terminals: Copper, solid, with adhesive bases for single-ply roof installations.

B. Air Terminal for Chimney: Lead-coated copper.

C. Grounding Rods: Solid copper.

D. Ground Plate: Copper.

E. Conductors: Copper cable.

F. Connectors and Splicers: Bronze with stainless steel screws.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor’s “Waste Management Plan” as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify that field measurements are as shown on shop drawings.

C. Beginning of installation means installer accepts existing conditions.

3.3 INSTALLATION

A. Install in accordance with NFPA 780, UL 96A and LPI-175.

B. Connect conductors using mechanical connectors.

C. Bond exterior metal bodies on building to lightning protection system.

D. Required system downleads shall be concealed within new or existing construction.

E. The lightning protection system ground shall be bonded to the building system ground. The bonding connection shall be by the Lightning Protection System Contractor.

F. When a new lightning protection system is installed and new service entrance equipment is involved, contractor must provide and install a UL Listed surge protection equipment on the service entrance equipment in order to receive full certification for a UL master label.

3.4 FIELD QUALITY CONTROL

A. Obtain the services of Underwriter's Laboratories, Inc. to provide inspection and labeling of the lightning protection system in accordance with UL 96A.

B. Perform inspection and testing in accordance with LPI-177.

C. Protect elements surrounding work of this Section from damage or disfiguration.

D. Obtain UL Master Label and attach to building at location directed by the Architect.

END OF SECTION 26 41 13

SECTION 26 43 13 - SURGE PROTECTIVE 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. This Section includes the following:

1. This section describes the materials and installation requirements for surge protective devices (SPD) for the protection of all AC electrical circuits from the effects of lightning induced currents, substation-switching transients and internally generated transients resulting from inductive and/or capacitive load switching.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 SUBMITTALS

A. Submit under provisions of Section 260500.

B. Shop drawings, product data and Manufacturer’s installation instructions for non-approved Manufacturers shall be submitted for review ten days prior to the bid date.

C. The submittals shall include:

1. Dimensional drawing of each suppressor type indicating the following:
   a. Service Entrance Suppressors:
      1) Copper bus bars (electrical grade copper 1.5 inches wide, 0.25 inch thick).
      2) Redundant modules on each phase.
      3) Replaceable 200,000 AIR fuses on each module.
      4) Line-to-neutral and neutral-to-ground suppression paths.
   b. Sub-panel Suppressors:
      1) Line-to-neutral, line-to-ground and neutral-to-ground suppression paths.

2. UL Standard 1449 Listing, Standard for Safety and Surge protective devices documentation.

3. UL Standard 1283 Listing, Electromagnetic Interference Filters documentation.

4. IEEE C62.41-1991 Category C3 (20kV-1.2/50, 10kA-8/20μs waveform) clamping voltage test results from an independent test lab.

D. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

1.4 COORDINATION

A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

1.5 WARRANTY

A. Written warranty, executed by Manufacturer agreeing to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.

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. Replaceable Protection Modules - one of each size and type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Advanced Protection Technologies, Inc.

B. Liebert.

C. General Electric.

D. Square D.

E. EATON/Cutler Hammer.

F. Surge Suppression Inc.

2.2 SERVICE ENTRANCE SWITCHBOARD

A. Switchboard Surge Suppressor:

1. Suppressors shall be listed in accordance with UL 1449 (Third Edition), Standard for Safety, Surge protective devices and UL 1283 Electromagnetic Interference Filters.

2. Suppressors shall be independently tested with the Category C3 high exposure waveform (20kV-1.2/50μs, 10kA-8/20μs) per ANSI/IEEE C62.41-1991.

3. Suppressors shall provide redundant suppression modules between each phase conductor and the neutral conductor and between the neutral conductor and ground.

4. Visible indication of proper suppressor connection and operation shall be provided. The indicator lights shall indicate which phase as well as which module is fully operable.

5. The suppressor shall incorporate copper bus bars for the surge current path. Small gauge round wiring or plug-in connections shall not be used in the path for surge current diversion. Surge current diversion modules shall use bolted connections to the bus bars for reliable low impedance connections.

6. Suppressors shall meet or exceed the following criteria:
   a. Maximum single impulse current rating shall be 150kA per phase. (L-N & N-G)
   b. Voltage Protection Rating (VPR) of 1200V at system voltage of 480/277. (L-N, L-G & N-G)
   c. The suppressor shall include an internal UL Listed disconnect switch.

7. The SPD shall be constructed using surge current modules (MOV based). Each module shall be fused with user replaceable 200,000 AIR rated fuses. The status of each module shall be monitored on the front cover of the switchboard as well as on the module.

8. The SPD shall be equipped with an audible alarm that shall actuate when any one of the surge current modules has failed. An alarm on/off switch shall be provided to silence the alarm and an alarm push-to-test switch shall be provided to test the alarm. Both switches and audible alarm shall be located on the front panel of the switchboard.

9. Terminals shall be provided for all of the necessary power and ground connections. Each terminal shall accommodate wire sizes of #8 to #1AWG.

10. The suppressor shall have a response time no greater than five nanoseconds for any of the individual protection modes.

B. Accessories:

1. A transient voltage surge counter shall be located on the front cover of the switchboard. The counter shall be equipped with a manual reset and a battery to retain memory upon loss of AC power.

2. A DB-9 connector shall be provided along with dry contacts (normally open or normally closed) to allow connection to a remote monitor or other system. The output of the dry contacts shall indicate a failure of a phase or the entire unit.

3. A remote monitoring device shall be provided to directly connect to the suppressor with a DB-9 connector for simple installation. The device will have indicator lights to monitor each AC phase for a fault or good condition and include an audible alarm to indicate module failure.

2.3 DISTRIBUTION & BRANCH PANELBOARDS

A. Surge Suppressor:

1. Suppressors shall be component recognized in accordance with UL1449, Standard for Safety, Surge protective devices and UL 1283, Electromagnetic Interference Filters.

2. Suppressors shall be independently tested with the category C3 high exposure waveform (20kV-1.2/50μs, 10kA-8/20μs) per ANSI/IEEE C62.41-1991.

3. Suppressors shall incorporate copper bus bars for the surge current path. Small round wiring or plug-in connections shall not be used in the path for surge current diversion.

4. Suppressors shall be constructed using surge current modules (MOV based). Each module shall be fused with user replaceable 200,000 AIR rated fuses. The status of each module shall be monitored on the front cover of the panelboard enclosure as well as on the module.

5. Suppressors shall be equipped with an audible alarm that shall activate when any one of the surge current modules has failed. An alarm on/off switch shall be provided to silence the alarm and an alarm to push-to-test switch shall be provided to test the alarm. The switches and alarm shall be located on the front cover of the panelboard enclosure.

6. Suppressors shall meet or exceed the following criteria:
   a. Maximum single impulse current rating shall be no less than 100kA per phase.
   b. Pulse Life Test: Capable of protecting against and surviving 5000 ANSI/IEEE C62.41 Category C transients without failure or degradation.
   c. The clamping voltage shall not exceed the following:

VOLTAGE	L-N	N-G	L-G
208Y/120	700 Volts	700 Volts	700 Volts
480Y/277	1200 Volts	1200 Volts	1200 Volts

7. The suppressor shall have a response time no greater than five nanoseconds for any of the individual protection modes.

8. Suppressors shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115 percent of nominal RMS voltage.

9. Visible indication of proper suppressor connection and operation shall be provided. The indicator lights shall indicate which phase as well as which module is fully operable.

10. Suppressors shall have a minimum EFI/RFI filtering of 34dB at 100kHz with an insertion loss ratio of 50:1 using Mil Std. 220A methodology.

B. Accessories:

1. A transient voltage surge counter shall be located on the front cover of the suppressor. The counter shall be equipped with a manual reset and a battery to retain memory upon loss of AC power.

2. A DB-9 connector shall be provided along with dry contacts (normally open or normally closed) to allow connection to a remote monitor or other system. The output of the dry contacts shall indicate a failure of a phase or the entire unit.

3. A remote monitoring device shall be provided to directly connect to the suppressor with a DB-9 connector for simple installation. The device will have indicator lights to monitor each AC phase for a fault or good condition and include an audible alarm to indicate module failure.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 SERVICE ENTRANCE

A. Install one primary suppressor within the switchboard or panelboard at each utility service entrance to the facility according to Manufacturer's recommendations.

B. The suppressor shall be installed on the load side of the service entrance.

C. Conductors between stand-alone suppressors and point of attachment shall be kept short and straight. Do not exceed Manufacturer's recommended lead length.

D. The suppressor's ground shall be bonded to the service entrance ground.

3.3 PANELBOARDS

A. Install panelboards as required and according to Manufacturer's recommendations. The surge suppression is external to the surge-protected panelboards.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control testing:

1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements.

2. Complete startup checks according to Manufacturer's written instructions.

3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.

B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

C. 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. Verify that electrical wiring installation complies with Manufacturer's installation requirements.

3.5 DEMONSTRATION

A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain surge protective devices.

1. Train Owner's maintenance personnel on procedures and schedules for maintaining suppressors.

2. Schedule training with Owner, with at least seven days advance notice. Allow four hours for Owner's training.

END OF SECTION 26 43 13

SECTION 26 51 00 - 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. This Section includes the following:

1. Interior and exterior luminaires and accessories.

2. Ballasts/drivers.

3. Lamps.

4. Poles.

B. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 DEFINITIONS

A. BF:

1. Ballast factor. Ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.

B. CRI:

1. Color rendering index. Scale used to measure the effect of a light source on the color appearance of objects in conscious or subconscious comparison with their color appearance under another (reference) light source.

C. CCT:

1. Correlated color temperature. Scale used to measure the color appearance of a light source. The CCT is the absolute temperature of a black body whose chromaticity most nearly resembles that of the light source.

D. CU:

1. Coefficient of utilization. Factor that represents the ratio between the lumens reaching the workplane and the total lamp lumens.

E. LER:

1. Luminaire efficiency rating, which is calculated according to NEMA LE 5. This value can be estimated from photometric data using the following formula:

2. LER is equal to the product of total rated lamp lumens times BF times luminaire efficiency, divided by input watts.

F. RCR:

1. Room cavity ratio. Factor that represents the relationship between the mounting height of a luminaire, area of the room, and proportions of the room, for the space between the luminaire plane and the workplane.

G. Custom Finish:

1. All metal finishes including brass, aluminum, copper, stainless steel, etc., with a surface texture of brushed, polished, satin, etched, or other style. Excludes precious metals such as gold, silver, and platinum unless specifically listed as an option by the specified Manufacturer. This option also allows for a custom-painted color to be selected.

H. Standard Finish:

1. Includes all metal finishes offered by the specified Manufacturer for the specified product.

I. Custom-Painted Color:

1. Any painted color as selected by the Professional. May be provided by paint Manufacturer catalog number or color chip sample. This could include textured or faux finishes if applicable.

J. Optional color:

1. Painted color chosen from the Manufacturer’s standard or optional color list.

K. Standard Color:

1. Painted color chosen from the specified Manufacturer’s standard list.

1.4 SUBMITTALS

A. Submit under provisions of Section 260500.

B. LEED Submittals

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1 and Credit MR 5.2: For products regionally manufactured materials and regionally extracted and manufactured materials.
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

3. See Sections 013515 and 013516 for LEED requirements for MR and EQ credits.

4. Lamp information for every fixture type must be submitted in a separate "Lamp Submittal" package and must include mercury content in milligrams and Picograms per lumen hour, initial and maintained lamp lumen values, CRI, CCT, and wattage. Lamps shall be considered non-hazardous waste by passing the EPA's Toxicity Characteristic Leaching Procedure (TCLP) at the end of life.

5. Ballast and driver submittals must clearly state that they do not contain Polychlorinated Biphenyl (PCB).

C. Substitutions

1. Under provisions of Section 260500.

2. The Engineer will review a substitution a maximum of three (3) times. After the substitution has been rejected two (2) times, the Contractor shall supply the product, as specified, in the third submittal.

3. The Contractor must submit any substitution request within 30 days of receiving the Notice to Proceed. Any substitution requests received after this period will be returned as "not reviewed." Substitution requests received within this time frame will be reviewed only for general conformity; approval to bid the substitution in no way waives the requirement for complete submittals after the contract is awarded. The onus remains on the Contractor to provide an equal fixture submittal to the specified product.

4. A substitution request that is submitted in the first 30 days, but returned as "rejected" or "revise and resubmit" must be resubmitted within 30 days of the returned submittal date for reconsideration.

5. No substitution requests will be accepted after the dates listed above. Substitution requests received outside of the listed timeframes will be returned as "not reviewed" and the contractor will be responsible for supplying submittals of the as specified product / basis of design. The Contractor will be fully responsible for any and all additional costs associated with project delays if the specified product is not available to meet the construction schedule.

D. Shop Drawings:

1. Every submittal must include the estimated lead time for delivery indicated on the submittal sheet. Failure to indicate lead time may result in the submittal's rejection.

2. Submittal must provide a physical description of the product, including: an image of the product, dimensions, components, ratings, and performance data for each luminaire. If the finish/color is not indicated on the fixture schedule, a complete finish/color palette shall be submitted.
   a. Performance data shall include photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurement Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this project.
   b. Testing Agency Certified Data: For indicated fixtures, photometric data shall be verified by a qualified independent testing agency. Photometric data for remaining fixtures may be certified by the Manufacturer's laboratory pending the laboratory carries a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   c. All LED fixture submittals must include test data for LM-79 and LM-80. A Lighting Facts label by the US Department of Energy may be submitted in place of the LM-80 test data. TM-21 test data shall be submitted if available.

3. Indicate wattage, bulb shape, voltage, dimensions, base type, burn orientation, CCT, CRI, beam angle, lumen output, efficacy, rated life, and frosting or coating information as applicable for each lamp type.

4. Indicate ANSI type, ballast factor, ballast efficacy factor, input watts, voltage, current, sound rating, and casing for each ballast & LED driver type.
   a. Dimming ballast & LED drivers must also indicate dimming range, starting characteristics, and provide written verification of compatibility with dimming devices and lamps.

5. Show details of nonstandard, modified, or custom fixtures.
   a. Include plans, elevations, sections, details, and attachments.
   b. Detail equipment assemblies, indicate dimensions, weights, loads, required clearances, methods of field assembly, components, features, accessories, installation procedures, relamping methods, and the location and size of field connections.
   c. Wiring diagrams for power, signal, and control wiring must be provided.
   d. Sample materials may be required for final selection and approval.
   e. Photographs of the custom or modified fixture may be required throughout the manufacturing process as a continuous quality assurance procedure.

6. Any submittal that adversely affects the energy efficiency by utilizing an increased power consumption will be rejected unless the submittal includes complete ComCheck verification for the project. The revised ComCheck submission must be approved by the Authority Having Jurisdiction prior to final approval of the substitution. The Contractor may choose to pay the Engineer to verify the product's code compliance through a revision of the project's original ComCheck submission.

7. The Engineer reserves the right to request a sample of any substitution in the submittal package. The sample must be shipped directly to the Engineer's office for review.

E. Manufacturer's Recommendations:

1. Indicate application conditions and limitations of use stipulated by the manufacturer or product testing agency specified under Regulatory Requirements.

F. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Samples for Verification:

1. For lighting fixtures designated for sample submission in the Lighting Fixture Schedule or during the submittal review process.

2. Lamps:
   a. Specified units installed.
   b. Ballast/driver:
      1) 120V models of specified ballast/driver types.
   c. Accessories:
      1) Cords and plugs.
      2) All specified accessories and optional features
      3) Pendant or wall mount support system, as applicable.

H. Operation and Maintenance Data Manuals must be provided prior to project closeout including:

1. All data required in the original shop drawing submittal.

2. One copy of the original installation and operation data that was included with the installed fixture, lamp, ballast, driver, transformer, or accessory.

3. Lamp data must include the general ANSI codes for replacement.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 260500.

B. Accurately record actual locations of each luminaire and control device.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories:

1. 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.

C. NFPA Compliance:

1. Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by NFPA.

D. NFPA 101 Compliance:

1. Comply with visibility and luminance requirements for exit signs.

E. Listing and Labeling: Provide fixtures that are listed and labeled for their indicated use on the Project.

1. The terms "Listed" and "Labeled" shall be as defined in the National Electrical Code, Article 100.
2. The Listing and Labeling Agency shall be a "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.7 COORDINATION OF TRADES

A. Contractor shall coordinate layout and installation of light fixtures with other construction trades including but not limited to HVAC, plumbing, fire suppression and warning, telecommunications, and security. This coordination shall ensure the ability to install light fixtures with proper mounting and clearances. The Contractor shall bring all conflicts to the Engineer’s attention as soon as possible before installation of either the lighting or the conflicting trade.

1.8 WARRANTY

A. Special Warranty for Emergency Lighting Unit Batteries:

1. Manufacturer’s standard form in which Manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

2. Warranty Period:
   a. Five (5) years from date of Substantial Completion. Full warranty shall apply for first year, and pro-rated warranty for the remaining four (4) years.

B. LED Fixture Manufacturer’s Warranty

1. Manufacturer shall provide a standard warranty form or other written notification on company letterhead addressed to the project owner agreeing to replace lamps, drivers, and/or fixtures that fail in the following areas within specified warranty period indicated below:
   a. Produce light meeting 70% of the initial rated light out as published on the shop drawing submittal.
   b. Color shift in excess of ±200 Kelvin in a perceptible manner.

2. Warranty Period:

a. Five (5) years from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Provide spare quantities for each different type of material as follows:

1. LED lamps/modules/circuit boards:
   a. Ten (10) percent of the total quantity installed, but not less than two (2) of each type. This quantity not to exceed a combined total of 35 LED lamps/modules/circuit boards of each type specified.

2. Glass and plastic globes, lenses, covers, and other optical assemblies:
   a. One (1) of each for every 25 shall be furnished to a maximum of ten (10) extra items of each type.

3. Ballasts, transformers, and LED drivers:
   a. Five (5) percent of the total quantity installed but not less than one (1) of each type and not more than 15 of each type.

B. Deliver replacement stock as directed by Owner to Owner’s storage space.

PART 2 - PRODUCTS

2.1 ACCESSORIES

A. Contractor shall provide the Owner with two (2) of each special tool required for replacing lighting fixture or any components, including lamps. The tools shall be new and shall be turned over to the Owner when the project is completed.

2.2 LUMINAIRES

A. Furnish products as specified in schedule.

B. The fixture Manufacturers' catalog numbers scheduled on the drawings in the fixture schedule may not include all the required accessories or hardware that is necessary for a complete installation.

C. Furnish luminaires with all associated appurtenances including, but not necessarily limited to, lamps, ballasts, reflectors, lenses and/or louvers, sockets, holders, suspension accessories, pendants, canopies, recessing boxes, plaster frames, and similar items completely wired, assembled, installed, and tested as specified and in the manner indicated.

D. All troffer-type lighting fixtures shall be designed to completely eliminate light leakage between the fixture body and doorframe and shall be provided with positive acting, hinge and latch flush doorframes.

E. All recessed lighting fixtures shall be provided with an integral, automatic resetting, thermal cutout.

F. All exterior fixtures shall be weatherproof, gasketed, and shall be installed with non-ferrous metal screws finished to match the fixture.

G. All Alzak-type of reflector cones and louvers used in downlights (or other fixture types where the reflector is visible) shall be specially anodized in order to eliminate iridescence.

H. Every lighting outlet shall have a lighting fixture unless otherwise directed. In instances where a specific type of fixture has not been assigned to an outlet, provide a complete fixture of the type and wattage designated for outlets of similar function and/or as directed by the Architect.

I. All lighting fixtures shall be UL listed or assembled from UL components.

2.3 FIXTURE TYPE IDENTIFICATION

A. Fixture types are indicated on the drawings and reflect the type of mounting, specific type or group of fixture, the total lamp wattage of the fixture.

B. Examples:

1. RA-120, SB-64, TC-50.

2. The first letter indicates the Type of Mounting. R=Recessed; S=Surface; P=Pendant; W=Wall; O=Outside or Exterior; T=Track.

3. The second letter indicates the specific type or group of fixture as hereinafter specified.

4. The number following the specific type indicates the total lamp wattage of the fixture under normal operation.

2.4 BALLASTS, TRANSFORMERS, AND DRIVERS

A. This section generally covers all ballast/transformer/driver types that may be used on this project. Any equipment specified in the fixture schedule with specific performance characteristics shall take precedence over the following specification section. If no other performance specifications are listed in the fixture schedule, all ballasts/transformers/drivers shall conform with the following section. Any specification below that does not apply to this project shall be disregarded.

B. All ballasts, transformers, and drivers shall be submitted to controls and lamp manufacturers to assure compatibility. Written verification of compatibility must be submitted with the lamp, ballast, and controls submittals respectively.

C. Low Voltage Transformers

1. Acceptable manufacturers:
   a. Q-tran
   b. Semper-fi

2. Performance Characteristics
   a. 5-year warranty minimum
   b. Provides five (5) different voltages simultaneously. Compensates for voltage drop due to long secondary wire runs.
   c. Powers 12 volt and 24 volt lighting.
   d. Fully loadable at any tap, or combination of taps with no de-rating required.
   e. Quiet operation even when dimming.
   f. Facilitates full-range dimming (0-100% light output).
   g. Provides equal light output to multiple loads at varying distances.
   h. Sizes ranging from 50 watts to 1400 watts with the ability to house multiple transformers in a single enclosure.

D. LED Drivers

1. Shall be UL listed and comply with ANSI C62.41 Category A for transient protection.

2. Shall be available in ratings to meet required application needs, including but not limited to: indoor, plenum, recessed, outdoor, wet location.

3. Shall have a Total Harmonic Distortion (THD) of less than 20%.

4. Shall have a power factor greater than 90%.

5. Shall have end of life detection and shut down.

6. Shall be class A sound rated.

7. Shall tolerate sustained open circuit and short circuit output conditions without damage and without the need for external fuses or trip devices.

8. Shall not contain Polychlorinated Biphenyl (PCB).

9. Shall have poke-in wire trap connectors or integral leads color coded per ANSI C82.11

10. Shall meet Federal Communications Commission (FCC) rules and regulations, Title 47 CFR Part 15, non-consumer (Class A) for EMI/RFI.

2.5 LAMPS

A. This section generally covers all lamp types that may be used on this project. Any lamp specified in the fixture schedule with specific performance characteristics shall take precedence over the following specification section. If no other performance specifications are listed in the fixture schedule, all lamps shall conform with the following section. Any specification below that does not apply to this project shall be disregarded.

B. Light-emitting diodes (LEDs):

1. Red LEDs utilized in exit and other signage must maintain at least 70% of their initial lumen output after 50,000 hours of operation.

2. LED's excluding exit sign
   a. Any substitutions must meet or exceed the performance characteristics of the LEDs utilized in the specified manufacturer's product.
   b. Shall be tested and be in compliance with the current edition of the Illuminating Engineering Society (IES) document LM-80, "Approved Method: Measuring Lumen Maintenance of LED Light Sources."
      1) LED light source life may not be predicted from LM-80 data. LED life must be calculated in accordance with the current edition of the IES document TM-21.
   c. Light fixtures utilizing integral LEDs shall be tested and be in compliance with the current edition of the IES document LM-79, "Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products."
   d. All parts, including luminaire, driver, driver enclosure, dimming interface (where applicable), LEDs, and other products shall be covered by the luminaire fixture manufacturer's warranty.
   e. Luminaires utilizing white LED arrays or blue LEDs with remote phosphor to produce white light shall produce white light with a CCT of 4000K.
   f. CRI for all LED sources shall be greater than or equal to 80 for interior luminaires and greater than or equal to 70 for exterior luminaires.
   g. Color consistency among individual fixtures within each fixture type must remain within 3 MacAdam ellipses of each other, throughout the duration of the warranty period.

2.6 EMERGENCY LIGHTING UNITS

A. Unless otherwise specified, emergency lighting units shall meet the following requirements.

B. Manufacturers:

1. Basis of Design – Lithonia "Indura" series
   a. INDX1236 (blank) LP05VS ULT.

2. Dual-Lite "Dynamo DYN" series

3. Mule Lighting "Patriot – NEMA 4X" series

4. Substitutions:
   a. Under provisions of Section 260500.

C. Description:

1. Self-contained emergency lighting unit.

D. Battery:

1. 12 volt, high-temperature nickel-cadmium or lithium iron phosphate type, with 1.5 hour capacity, fully warranted for 3 years minimum and pro-rated for 5 years.

E. Battery charger:

1. Dual-rate type, with sufficient capacity to recharge discharged battery to full charge within 12 hours.

2. Current limiting charger.

3. Unit shall have thermal protection to prevent overheating and charger failure.

F. Lamps:

1. Two (2) LED lamps, 5-6 watts (max.) per lamp.

G. Remote lamps:

1. Match lamps on unit.

H. Housing:

1. Heavy duty polycarbonate with color molded through or heavy duty die-cast aluminum with painted finish.

2. Finish color shall be gray.

I. Lens:

1. Impact-resistant, corrosion-resistant, clear, polycarbonate lens.

2. Gasketed and sealed to housing.

J. Hardware:

1. Stainless steel, tamper-resistant screws.

K. Indicators:

1. Provide lamps to indicate AC ON and RECHARGING. Provide voltmeter and audible feature.

L. Provide TEST switch to transfer unit from external power supply to integral battery supply.

M. Provide self-diagnostics and time delay features.

N. Provide heater, thermostat, and/or battery blanket for cold temperature operation. Unit shall be rated for temperatures down to -22°F (-30°C) or lower; and unit shall be rated for temperatures up to 104°F (40°C) or higher.

O. Electrical connection:

1. Conduit connection.

P. Voltage:

1. Dual voltage input (120/277).

Q. Unit shall have the following listings:

1. Wet location

2. UL 924

3. NEMA 4X

4. IP66 or greater

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection, and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 EXAMINATION

A. Examine substrate and supporting grids for luminaires.

B. Examine each luminaire to determine suitability for lamps specified.

3.3 INSTALLATION

A. Install in accordance with Manufacturer's instructions.

B. Install suspended luminaires using aircraft cable, unless otherwise specified in the fixture schedule. Provide length required to suspend luminaire at indicated height.

C. Support luminaires larger than 2 foot by 4 foot size independently of ceiling framing. Electrical Contractor shall furnish all necessary additional auxiliary supporting steel for fixtures not mounted on building framework, and where necessary, to span the ceiling channels of hung ceiling construction. Fixtures supported by ceiling framing members shall be securely attached to the framing members in a manner approved by the National Electrical Code.

D. Fixtures and/or fixture outlet boxes shall be provided with hangers to adequately support the complete weight of the fixture. Design of hangers and method of fastening other than herein specified shall be submitted to the Architect for approval. Fixtures mounted on outlet boxes shall be rigidly secured to a fixture stud in the outlet box. Hickies or extension pieces shall be

installed where required to facilitate proper installation. Fixtures that weigh more than 50 pounds shall be supported independently of the outlet box.

E. Provide aligner hangers for stem-suspended fixtures so that fixtures hang level with vertical stems.

F. All fixtures of the same type and within the same visible area shall be installed so that the lamps in all the fixtures are parallel and aligned with the building lines and with each other.

G. All fixtures with Alzak reflectors (i.e., downlights, etc.) shall be installed such that there is no permanent damage caused by fingerprints or other body oils.

H. Unless otherwise noted, locate surface, pendant, and recessed ceiling luminaires as indicated on reflected ceiling plan; in all other areas refer to lighting plan. Coordinate with other disciplines.

I. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.

J. Exposed Grid Ceilings:

1. Fasten surface mounted luminaires to ceiling tee using bolts, screws, rivets, or suitable clips.

K. Install recessed luminaires to permit component removal from below.

L. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating. Refer to architectural finish schedules for locations where this occurs.

M. Install clips to secure recessed grid-supported luminaires in place.

N. Install wall mounted luminaires and exit signs at height as indicated on drawings or in schedule.

O. Unless otherwise indicated, luminaire mounting heights are to bottom of unit for suspended items and to center of unit for wall-mounted items.

P. Install accessories furnished with each luminaire.

Q. Connect luminaires and exit signs to branch circuit outlets provided under Section 260534.

R. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

S. Bond products and metal accessories to branch circuit equipment grounding conductor.

T. Install specified lamps in each luminaire.

U. All recessed wallslot wall washing type systems shall be furnished with lens luminance deflector directly beneath light source for visual shielding when specified, and all extensions, corners, caps, and similar accessories, in order to provide a complete system continuous to

within 6 inches wall to wall. Actual illuminated length shall be centered in entire fixture length with equal extensions at each end.

V. All lighting contained within architectural details (i.e., cove, slots, valances, etc.) shall be continuous with fixtures tightly butted up against each other to reduce socket shadows. Actual illuminated length shall be centered in overall detail with equal spacing at each end. All concealed lighting of this nature shall be closely coordinated with architectural details where indicated in fixture schedule.

W. The Electrical Contractor shall consult the Room Finish Schedule as to the type of ceiling construction and shall be responsible for ordering the proper fixtures and hardware required for installation in or on a specific room surface.

X. Fixtures shall be installed so that no labels will be visible under normal operating conditions of the fixture.

1. Recessed fixtures shall be designed to fit the make and type of ceiling to be installed, and shall include plaster frames where installed in plaster or gypsum board ceilings.

2. Recessed fixtures shall be removable from below to allow access to an outlet box in the ceiling, as required by the NEC.

Y. All luminaires with louvers, blades, or baffles shall be installed so that the louvers, blades, or baffles are aligned with the building lines and with each other.

3.4 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Tests and Observations:

1. Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source. Inspect for proper connection, operation, lamp type, and ballast/driver type.

2. Verify emergency operation of lighting units after installing luminaires and energizing emergency power circuits. Inspect for proper connection, operation, lamp type, ballast/driver type, and battery type, where applicable.

3.5 ADJUSTING

A. Unless otherwise indicated, aim and adjust all downlight / wash lights and adjustable accents to aim flat against nearest adjacent walls.

B. Adjust exit sign directional arrows as indicated.

C. Re-lamp luminaires at Owner's final acceptance of project for the following reasons:

1. Failed lamps.

2. LEDS that have been used 3,000 hours or more for temporary or construction lighting.

3.6 EMERGENCY FIXTURE IDENTIFICATION

A. All emergency-only lighting fixtures shall be identified by providing a red plastic stick-on dot ½-inch in diameter on the exposed fixture corner flange or the adjacent ceiling support member. Fixtures shall be marked at the same location for uniformity.

3.7 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosure.

C. Clean photometric control surfaces as recommended by Manufacturer.

D. Clean finishes and touch up damage as directed by Architect or Owner.

3.8 DISPOSAL

A. All ballasts containing PCB's and batteries shall be treated as hazardous waste and disposed of as regulated by the Environmental Protection Agency's Universal Waste Rule. Any state regulations more stringent shall take precedence.

B. All fluorescent and HID lamps shall be treated as hazardous waste and recycled as regulated by the Environmental Protection Agency's Universal Waste Rule. Any state regulations more stringent shall take precedence.

1. Lamps recognized as having reduced mercury content and passing the Toxicity Characteristic Leaching Procedure (TCLP) shall be excluded.

END OF SECTION 26 51 00

SECTION 26 55 61 – THEATRICAL LIGHTING AND CONTROLS

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 equipment for a small theater / TV studio lighting system, including fixtures, lamps, dimmers, controls, and distribution components.

1.3 SUBMITTALS

A. Product Data: For fixtures, lamps, distribution components, and control systems, including dimensions and data on features and components. Include data on ratings and features of devices.

B. Shop Drawings: Detail dimmer equipment showing arrangements, characteristics, and circuit assignments of various modules. Include elevation views of front panels indicating devices and controls. Include illustrations and dimensioned drawings.

1. Wiring Diagrams: Detail wiring for power and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Manufacturer Certificates: Signed by the manufacturer certifying that they comply with requirements. Include evidence of manufacturing experience.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Maintenance Data: For fixtures, distribution equipment, software operating manuals, instructional videotapes, and controls are to be included in maintenance manuals specified in Division 1.

F. Record Data: Show connections and circuit and channel assignments.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has installed systems of similar scope and function as the units required for this project.

B. Manufacturer Qualifications: A firm experienced in manufacturing equipment similar to that indicated for this project that maintains technical support service available by toll-free telephone number. Service capability to provide the user with training, parts, and emergency maintenance and repairs support within 48 hours maximum response time.

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.

D. Comply with NFPA 70.

1.5 EXTRA MATERIALS

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: 1 for every 10 of each ANSI code, type, and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

1. Basis of Design: Lehigh Electric Products Company.

2. Electronic Theatre Controls, Inc. (ETC)

3. Strand Lighting, Inc.

B. Other manufacturers wishing to be considered for prior approval must submit the following items a minimum of 10 days prior to the bid date. Approval to bid does not waive the requirement to comply with the equipment specifications listed in this section.

1. A complete bill of material listing all proposed equipment.
2. Catalog sheets detailing the products proposed in 1 above,
3. Description listing any deviations the proposed substitution has as compared with the specified system.
4. Detail additional costs associated with using the alternate system in lieu of the specified system.

2.2 FIXTURES AND DISTRIBUTION EQUIPMENT, GENERAL

A. Metal Parts: Free from burrs and sharp corners and edges.

B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support sheet metal to prevent warping and sagging.

C. Fixture Doors and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without the use of tools. Arrange doors, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.

D. Pigtail: Factory wired 36-inch (900 mm) long, 3-wire cord and plug connector assembly with cord encased in woven fiberglass or silicone tubing.

E. Plug Connectors: Two-pole, 3-wire, 20-A parallel blade type.

F. Pipe Clamps: Malleable iron and designed for clamping fixtures to 3/4- to 2-inch OD pipe and equipped with a T-bolt to lock alignment. Arrange fixture clamps for horizontal rotation of yoke for aiming.

G. Safety Cables: Heavy duty, flexible steel, 30-inch (760) nominal length, with spring clip at one end and steel ring at other.

H. Fixture Ventilation Openings: Baffled against light leaks.

I. Fixture Operating Controls and Handles: Thermally insulated.

J. Lenses: Borosilicate glass in silicone mountings.

K. Color Filter Frame Holder: Attached to front of fixture.

L. Fixture Yoke: Rigid metal arranged for vertical aiming of unit and equipped with T-bolt or hand screw to lock alignment.

2.3 FIXTURES

A. General: Listed under UL 1573.

B. Standard Features: Equip each fixture with pigtail, yoke with pipe clamp, and safety cable for batten mounting, and filter holder.

C. Cyclorama Floodlights: Multicolor, RGBA, LED fixture with 8 or 16 bit DMX control of intensity and color. Fixture shall be designed to provide a color wash of cyclorama curtains.

1. Lightweight aluminum housing. Fixture weight to be approximately 11 pounds.
2. Asymmetrical, specular aluminum reflector providing even asymmetrical distribution of light.

3. Integral multi-voltage power supply, 100-240VAC. 10A push button circuit breaker.
4. 6’ power cable with molded Edison plug. Feed thru power connectors for up to 6 units.
5. Convection cooled operation with no fans for operation within a 1°C to 400°C range. IP-20 rating for dry location use.
6. Compatible with DMX and RDM protocols. Feed thru 5 pin XLR connectors. Field angles: Approximately 82° horizontal and 37° vertical.
7. Preprogrammed modes for fixed colors and color mixes, timed color changes, and strobes.
8. Three adjustable feet for floor mounting or pipe mounting with optional yoke and c-clamp.
9. 100 Watts maximum output at full RGBA using 3 Watt Red, Green, Blue, and Amber LEDs. LEDs to have a 50,000 hour nominal life rating.
10. Fixture to include a local control keypad for configuration settings of DMX-512A address, fixture personality, and stand alone operation.
11. Fixture to be complete with 6’ power cord, 10’ DMX cable, safety cable, yoke and c-clamp.
12. Provide:
    a. Four (4) – Spectra Cyc 100.

D. PAR Spotlight – LED: Eight inch 100 watt rated. Provide c-clamp, Edison style parallel plug, and safety cable as described above.

1. Aluminum die-cast construction.
2. Four lens kit to include NSP, SP, MFL, and WFL 8” hi-temp glass lenses.
3. Luxeon Rebel LED’s – 100 watt Max at full RGBA output.
4. Compatible with DMX and RDM protocols.
5. Supplied with 3 meter DMX in and out cables with DMX connector.
6. User selectable for 8 and 16 bit personalities for smooth dimming.
7. PowerCon in and out connectors.
8. Supply with power and DMX cables as required for installation as shown on the plans
9. Provide:
    a. Ten (10) – LSPP-RGBA-LED.
    b. Six (6) – 8”, 4 door, 8 leaf barn-door assemblies

E. Ellipsoidal Spotlights - LED: Multicolor, RGBA, 250W LED fixture with 8 or 16 bit DMX control of intensity and color.

1. Housing: Die-cast aluminum and sheet metal housing construction. Tool-free interchangeable barrels. 360-degree rotating barrel.
2. Yoke: Rigid flat steel with dual locking dog tilt handles, two mounting positions, indexed tilt angle markings.
3. Light Engine: RGBA, 50,000 hour LED Life. Quiet fan cooling for 250W.
4. Lenses: Color coded crown glass (white plate) lenses provided with anti-reflective coating. Molded front lens made out of polymeric plastic for 5 and 10 degree units only.
5. Body Color**:** Black.

6. Rating: 100-240volt 50/60Hz Universal Power Input.
7. Electrical & Data: PowerCON® in and out connections. 5-pin DMX in and out. Requires power from non-dim source.
8. Shutters: Four .037" stainless steel, fully adjustable and lockable. Constructed with oversized heat resistant handles.
9. Completely enclosed accessory holder.
10. Provide:
    a. Six (6) – LE6P-LED-250-36

F. TV Studio Accessories

1. Cables:

    a. Provide: Six (6) – LECPBG/10' and six (6) – LECPBG/5'

    b. Provide: Four (4) – Twofers

    c. Provide: Six (6) – 10' ProCon to ProCon

    d. Provide: Twenty-four (24) – 10'

2. Castered stand with 5' to 9' extension.

    a. Provide: three (3)

G. Pipe Grid: Size and type as indicated in architectural documents.

1. Rigidly fasten the top row of pipes on 4' centers to the building structure. Mount the SlimDim strips to these pipes.
2. The bottom layer of pipes is to be fastened perpendicular to upper pipes with double pipe fittings at each cross point.
3. Anchor both layers of pipes to a side wall with wall flanges or similar fasteners. Connect the grid assembly at each pipe intersection to the building structure.

2.5 LIGHTING CONTROL SYSTEM

A. Description: Microprocessor-based, digitally controlled, distributed dimming system controlled by a remote control console. System to be SlimDim series with prewired dimmer assemblies mounted in a sheet metal enclosure with a black powder-coat finish and silk-screened legends.

B. SlimDim – Pipe Mounted

1. Mounting: Furnished with a pipe clamp, safety cable, and integral safety cable brackets.
2. Dimensions: 4.25" high, 2.5" deep, and 60" long.
3. Power input: 10' SO cord for 120/208V, 3 phase (20 amp) power feed with a NEMA L21-20 (4 pole, 5 wire grounding) locking connector and mating power receptacle in a screw cover electrical box.
4. Convenience outlet. 20 amp duplex receptacle for constant power.

5. Available in dimmer or non-dim models with any combination of dimmer or non-dim modules. Three modules per SD6 unit:
   a. Dimmer modules:
      1. Two independent dimmers.
      2. Dimmer output: One flush mounted stage pin output receptacle per dimmer.
   b. Non-dims modules:
      1. Non-dims: Two independent non-dim relays
      2. Relay output: One flush mounted parallel blade outlet per relay
6. Isolated DMX512A output connectors with each non-dim pair.
7. UL and cUL listed under Industrial Control Equipment.
8. Wireless DMX option provides wireless DMX transmission from the console to the SlimDim. Units with wireless DMX option shall include a wireless DMX antenna and receiver integral to the dimmer housing and one DMX out receptacle.
   Operation limits:
   a. Temperature range: Convection cooled (0° to 40° C ambient temperature) with thermal overload protection. Fans are not acceptable.
   b. Line voltage range: 90 to 140 volts.
9. Provide:
   a. 3 – SD6-3-3D-0ND-XXGP-CC/SC/PC10/PR/WD [Pipe mounted SlimDim complete with 6 (1200W) dimmers, pigtail receptacles (type to match theatrical light fixture plugs), c-clamps, safety cables, 10’ power cord with connector, wireless DMX receiver, and mating power receptacle].

E. SlimDim – Wall Mounted

1. Mounting: Furnished with wall mounting brackets.
2. Dimensions: 8.5” high, 2.5” deep, and 16” long.
3. Power input: Terminal blocks suitable for a 120V, 1 phase, 3 wire (20 amp) power feed.
4. Available in dimmer or non-dim models:
   a. Dimmers:
      1. Two independent dimmers with 10 amp fully magnetic circuit breaker for each dimmer and 350 micro-second (10%-90%) toroidal chokes.
      2. Dimmer output: One flush mounted stage pin output receptacle per dimmer.
   b. Non-dims:
      1. Non-dims: Two independent 10A continuous duty relays with 10 amp fully magnetic circuit breaker for each relay.
      2. Relay output: One flush mounted parallel blade outlet per relay
5. UL and cUL listed under Industrial Control Equipment.
6. Wireless DMX option shall provide wireless DMX transmission from the console to the SlimDim. Units with wireless DMX option shall include a wireless DMX antenna and receiver integral to the dimmer housing and one DMX out receptacle.
7. Operation limits:
   a. Temperature range: Convection cooled (0° to 40° C ambient temperature) with thermal overload protection. Fans are not acceptable.
   b. Line voltage range: 90 to 140 volts.

8. Provide:
   a. 3 – SD2-1-D-XXGF-WB/WD [Wall mounted SlimDim complete with 2 (1200W) dimmers, flush receptacles (type to match theatrical light fixture plugs), wall mounting brackets, and wireless DMX receiver].

9. Dimmer Performance:

   a. Temperature range: Convection cooled (0° to 40° C ambient temperature) with thermal overload protection. Fans are not acceptable.
   b. Line voltage range: 90 to 140 volts.

F. Electronics:

1. Digital, dimmer control circuitry.
2. Digital receiver module with programming keys, dimmer LEDs, and LED display:

   a. Accepts DMX512A control protocol with an optically isolated input per BSR E1.11 and is RDM ready.
   b. Programmable dimmer to channel patch for up to 512 DMX channels.
   c. Assign each dimmer's control mode to incandescent/low-voltage, fluorescent (2-wire dimmable phase control ballasts), or non-dim operation.
   d. LEDs indicate dimmer active status.

3. Test and operation modes:

   a. Ramp test: Sequentially turns each dimmer on then off at a programmable output level.
   b. Focus check: Operate a selected dimmer at an output level.

4. DMX, overtemp, and power LED indicators.
5. Programmable min and max output levels for each dimmer.

G. Control Console: Console to be a digital, 32-bit microprocessor controller with user selectable two scene manual or 250 cue memory control. Console to meet or exceed the Lehigh Wave Series as specified below:

1. General:

   a. Manual 2-scene control with 30 control channels per scene.
   b. Manual single-scene control with 2 pages of 60 control channels (120 total) per scene.
   c. Two pages of 60 submasters (120 total).
   d. 5 independent control channels.
   e. Up to 250 cues per show.
   f. Live or blind recording of cues, submasters, and effects.
   g. 4 x 20 Backlit LCD display to display channel levels, cues, submaster, patch and other control information with alphanumeric labeling of cues, submasters, and shows.
   h. Output/input interfaces:

      1) DMX-512 input and output receptacles.

2) USB port A for flash drive interface to record show files and input software upgrades.
3) USB port B for PC interface.
4) Ethernet port.

i. Grandmaster with Blackout.
j. Dimmer rack overtemp warning indicator LED.
k. Dimensions: 35”W X 4”H X 13.25”D

2. LCD display functions:

a. Preview/edit channel levels, cues, submasters, and effects.
b. Playing back the cue stack.
c. Preview/edit patch.
d. Show storage and retrieval.
e. Context sensitive help function.

3. Channels

a. Two rows of 30 channel controllers with bump buttons in a two scene format.
b. 60 channel single scene mode with two pages for 120 control channels.
c. All single and two scene channels to have normal and solo bump control function plus bump master level controller.
d. 5 independent control channels.
e. Focus check function.

4. Cues:

a. Cues to be recorded live or blind.
b. 250 cues per show with alphanumeric labeling.
c. A cue can be an effect with effects programmable to any cue. Activating the cue activates the associated effect.
d. Any cue, submaster, effect step, or combination look can be copied and pasted or inserted to any cue, submaster, or effects list.

5. Faders:

a. A and B fader pairs with Go and Hold. Separate up and down fade time controls.
b. Timed fades may be stopped, changed to manual, held, or modified at anytime during the fade.
c. LCD displays the cue fade time.
d. Cues can be stepped through quickly without fade times.

6. Submasters:

a. 60 pile-on submaster controllers with normal and solo bump button control.
b. Two submaster memory pages for a total of 120 submasters.
c. Submasters recorded live or blind.

d. A submaster is activated by a submaster controller or bump button when in the submaster mode and will pile-on to any active control settings.
e. Effects programmable to any submaster. Activating the submaster activates the associated effect. Multiple effects and submasters may run simultaneously.

7. Effects:

a. Assignable to any cue or submaster.
b. Up to 50 steps per effect.
c. Adjustable step speed.
d. One-shot mode or run continuously in forward, reverse, bounce, or random directions.
e. Step fade options for down-up, build, or snap.

8. Patch:

a. Program a dimmer to channel patch for up to 512 dimmers on 120 channels.
b. One-to-one patch or channel selectable.
c. Programmable dim or non-dim function.

9. DMX Backup:

a. A full 512 channel DMX universe can be input and stored as a cue or submaster which allows the console to serve as a backup with stored cues from another console.
b. Master level controller for DMX input.
c. DMX backup cues are stored as 512 channels. Patched input DMX channels are mixed HTP with active console channels.

10. Operating Modes

a. 2-scene: 2-scene preset manual operation with timed crossfades and pile-on submasters and effects.
b. 1-scene: Single scene preset manual operation with timed crossfades and pile-on submasters and effects.
c. Program: Recording of cues, submasters, and effects.
d. Playback: Playback of cues, submasters, and effects.
e. Setup: Patching and loading/saving show files.

11. Console receptacle stations for remote console operation. Provide in locations as shown on the drawings.
12. Provide: One (1) – Wave 120 console with a wireless DMX transmitter.

F. FINISHES
a. Manufacturers' standard, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment according to the manufacturer's written instructions. Set permanently mounted items plumb and level and square with ceilings and walls.

B. Mounting of Equipment: Conform to manufacturer's instructions and Division 26 Section "Supporting Devices." Mounting heights indicated are to bottom of unit for suspended items and to center of unit for wall-mounted ones.

3.2 CONTROL WIRING INSTALLATION

A. Install wiring between control devices as specified in Division 26 Section "Wires and Cables" for hard-wired connections. Install wiring in raceway except cable and plug connections.

B. Wiring in Enclosures: Bundle, train, and support.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Arrange and pay for the service of a factory-authorized service representative to test, adjust, and program the lighting control system.

B. Schedule visual and mechanical inspections and electrical tests with at least 21-days advanced notification.

C. Electrical Tests: Perform according to manufacturer's instructions. Exercise caution when testing devices containing solid-state components.

3.4 CLEANING AND ADJUSTING

A. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars of finish to match original finish. Clean fixtures, devices, and equipment internally and externally using methods and materials as recommended by manufacturers.

3.5 DEMONSTRATION

A. Demonstrate the system to prove compliance with requirements.

B. Direct Training: Arrange and pay for the services of a factory-authorized service representative to demonstrate the lighting control system and train the Owner's personnel.

1. Conduct a minimum of 1 day of training in operation and maintenance as specified under "Instructions to Owner's Employees" in Division 1 Section

"Project Closeout." The training is to include system operation and maintenance procedures.

2. Schedule training with at least a 21-day advance notification.

3.6 COMMISSIONING

A. Operational Tests: Energize lighting controls systems, program controls, and check controlled outlets for light levels.

B. Correct deficiencies and retest deficient items. Verify by the system tests that specified requirements are met.

END OF SECTION 26 55 61

SECTION 27 05 00 - TELECOMMUNICATIONS PATHWAYS AND SPACES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Telecommunications Room Build out

B. Pathways for Telecommunications Systems

C. Grounding and Bonding for Telecommunications

1.2 REFERENCES

A. Industry Codes, Standards and Methods shall be observed, including the following:

1. ANSI/TIA/EIA-568-B.1: Commercial Building Telecommunications Cabling Standard Part 1 – General Requirements
2. ANSI/TIA/EIA-568-B.2: Commercial Building Telecommunications Cabling Standard Part 2 – Balanced Twisted Pair Cabling Components
3. ANSI/TIA/EIA-568-B.3: Commercial Building Telecommunications Cabling Standard Part 3 – Optical Fiber Cabling Components
4. ANSI/TIA/EIA-569-A: Commercial Building Standard for Telecommunications Pathways and Spaces
5. ANSI/TIA/EIA-570-A: Residential Telecommunications Cabling Standard
6. ANSI/TIA/EIA-606: Administration Standard for Telecommunications Infrastructure of Commercial Buildings
7. ANSI/TIA/EIA-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
8. ANSI/TIA/EIA-758: Customer-Owned Outside Plant Telecommunications Cabling Standard
9. BICSI Telecommunications Distribution Methods Manual (TDMM), Latest Edition
10. National Fire Protection Agency (NFPA-70): National Electrical Code (NEC)

B. Comply with all local, state and federal codes for telecommunications installations.

1.3 SYSTEM DESCRIPTION

A. Design Requirements

1. Contractor shall outfit all telecom rooms according to T Drawings. Racks and other termination and distribution fields shall be installed according to manufacturer’s guidelines and industry standards.
2. TR and TER layouts shall be approved by school Technology personnel prior to installation of cabling, pathways or termination hardware.

B. Performance Requirements

1. Materials and equipment will be installed in an orderly and precise manner. Clearances between equipment will prevent incidental damage or unsafe conditions.

2. Equipment shall provide proper support and housing of all intended active and non-active components.

3. Refer to Telecom Room Details for precise location of equipment and termination fields.

1.4 SUBMITTALS

A. Product Data

1. Provide product data for all equipment listed in Part 2

2. Equipment data must be submitted in a single package and clearly indicated for efficient review. (by specifications section) Equipment submittals not clearly called out will be rejected without question at the contractor's expense for resubmittal.

3. Product data must be approved by designer and owner prior to purchase and installation of equipment.

B. Shop Drawings

1. Provide scaled drawings to show proposed equipment locations, clearances and administrative labeling of Telecom Rooms and equipment. All fields, racks and cabinets shall be methodically documented and permanently labeled agreed upon by school district.

2. Shop drawings must be approved by the designer and owner prior to purchase and installation of any equipment.

C. As-Built Drawings

1. Contractor shall upon completion of the project, provide a complete set of As-Built drawings. These drawings shall identify room numbers and outlet identification numbers for all low voltage cabling systems. Drawings should also include all IDF and MDF locations with a detailed layout of all racks, patch panels, trays, and wall fields.

2. Additional project information shall include Reline Details of all horizontal and backbone cable routes and pathways.

3. As-builts shall be submitted in electronic CAD format and in hardcopy at the end of the project.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements

1. All equipment shall be installed in a neat and professional 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 school district. Equipment and materials shall be of the quality and manufacturer 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. Substitutions

1. Conditions for consideration of "Or Equal" Products: Where products are specified by name and accompanied by the term "or equal", the proposed "or equal" product will be considered when the following conditions are satisfied.

a. If all the following conditions are not satisfied, Design Consultant will return requests without action, except to record noncompliance with these requirements

b. Proposed product does not require extensive revisions to the Contract Documents.

c. With the exception of the product name or number and manufacturer's name, proposed product conforms with requirements indicated on the Drawings and in the Specifications in every respect and will produce indicated results.

d. Proposed product is fully documented and properly submitted.

e. Proposed product has received necessary approvals of authorities having jurisdiction.

f. Proposed product is compatible with and has been coordinated with other portions of the Work.

g. Proposed product provides specified warranty.

2. If proposed product involves more than one contractor, proposed product 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.

3. Submission is accompanied with 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.

4. Submission is accompanied with a list of similar installations for completed projects with project names and addresses and names and addresses of design consultants and authorities, if requested.

5. Submission is accompanied with proposed product's Manufacturer signed written statement on Manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents.

1.6 WARRANTY

A. Warranty: Installer must provide manufacturer's warranty without cost to the owner during that time period, including materials, hourly costs, etc,.

B. Installer's warranty shall guarantee workmanship for a period of one year, during which time any deficiency in installation shall be repaired or replaced at no additional cost to the school district. Contractor must respond within 2 business days of written notification.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Distribution Racks and Cabinets

1. Floor Mounted Free Standing 2 Post Racks

a. Hubbell HPW84RR19

b. Hubbell HC219CE3N

c. Hubbell XS1010

d. Or approved equal from Cooper B-Line, Ortronics and Systimax.

2. Floor Mounted Free Standing 4 Post Racks

a. Four post aluminum frame with EIA rails

b. 45 Rack Units

c. Black

d. Similar to Ortronics OR-MM67SVR or approved equivalent.

3. Floor Mounted Equipment Cabinet

a. The cabinet frame shall be constructed of four cold rolled steel components – top, bottom, left and right welded to form a self supporting framework. The side members shall be fabricated from 16ga cold rolled steel. The top and bottom shall be fabricated from 14ga cold rolled steel. The vertical uprights shall have integral cable management channels with provisions for hook and loop or traditional cable ties. The frame shall be bolted to the floor, and side by side to other frames.

b. The side covers shall be constructed of 19ga cold rolled steel with double bent flanges along the entire perimeter. The side covers shall lift off easily via grip handles assembled to the covers. The side cover shall have clusters of rectangular perforation to accommodate ventilation for equipment providing greater than 100 sq. in. of ventilation.

c. The front door shall be a window door assembled to the frame via spring-loaded hinges at the top and bottom. The door shall be locking with a unique operator's key. The operator's key shall operate the front door only. The latch shall be flush to the door. The window shall be a .125" acrylic panel secured to a reinforced steel frame.

d. The rear door shall be a steel door assembled to the frame via spring-loaded hinges at the top and bottom. The door shall be locking with a unique service personnel key. The service personnel key shall operate both the rear and front doors. The latch shall be push button operated. The rear door shall be reinforced and have a cluster of rectangular perforations for ventilation.

e. The top shall have a removable panel in the center, designed to be replaced with a cooling fan, and six 3" diameter cable entry knockouts; three along each side to route cables directly into vertical cable organizers minimizing the number of bends to the cables.

f. The bottom panel shall be similarly configured with 6 knockout locations. The cabinet bottom shall also be provided with holes for securing the cabinet to the floor.

g. The top cover shall accept the mounting of a 250 CFM cooling fan.

h. The cabinet shall be pre-configured for 19" mounting with universal hole spacing per EIA 310 D. The cabinet shall feature three sets of rails, front, center, and rear. The front set of rails shall be 20 rack positions high, from the bottom of the cabinet. The rear and center rails shall be the full internal height. The recess of all three sets of rails shall be adjustable forward and back. The rails shall be tapped for a #10-32 screw. The center rails shall be formed in a 'C' profile, 3" deep tapped on both the front and rear flanges so as to provide the functionality of an open frame rack. The front and rear rails shall be an L shape.

i. The entire enclosure shall be finished with a durable polyurethane powder coat – medium texture, and shall be available in black.

4. All racks and cabinets shall be capable of supporting the weight and space of existing and proposed equipment. 30% growth capacity shall be provided in addition to detailed requirements.

5. Racks, cabinets and other termination equipment shall be properly secured to floor with appropriate anchors and bonded to Telecommunications Grounding System.

6. Unit shall be similar to Ortronics OR-DCC422846-00002 or approved equivalent.

7. Provide (1) 8-port transient surge protection strip for each TR and per rack/cabinet in the TER and TRs.

B. Cable Management

1. Horizontal Cable Management

a. Horizontal wire management panels are required for patch panels in certain racks. (See drawings for rack diagrams.)

b. Horizontal cable management shall occupy 1 or 2 rack units, as shown on T Drawings.

c. Similar to OR-MM6HMF1RU or approved equivalent

2. Vertical Cable Management

a. Vertical Cable management shall be provided for all racks. Provide 2 for each rack or cabinet.

b. Cable management shall be – Ortronics OR-60400510, or approved equivalent.

C. Ladder-Type Aluminum Cable Tray (Ladder Rack)

1. All TR and TER locations shall receive ladder-rack style cable tray as shown in T-series drawings for cable distribution.

2. Class 5160 or Chatsworth "TELCO-Style Cable Runway," 12 inch ladder rack from racks/cabinets from corridor or other wire routing space where indicated on drawings.

D. J-Hooks

1. Cooper B-Line BCM-21, 23 or 64.

E. Conduit (electrical installed)

1. In-wall conduit shall be provided for work in new areas. Refer to T Drawings for conduit details.
2. Conduit bend radii shall follow current TIA/EIA standards for telecommunications.
3. Refer to T drawings for locations and sizes of all sleeves for telecommunications.

F. Gang Boxes

1. In-wall Gang Boxes for low voltage
   a. See electrical for back boxes.

G. Surface Mounted Raceway (SMR)

1. Surface mounted split channel raceway for power and data - Wiremold 4000
   a. Coordinate all Wiremold for telecom equipment with electrical installer.
   b. Provide associated colored connectors (see 271250) and faceplates per manufacturer's recommendations for telecommunications.
   c. Coordinate color and finish with architect prior to installation

H. Floor Boxes and Poke-through Device

1. Small Capacity In-floor box
   a. Coordinate all floor boxes and poke-through devices for telecom equipment with electrical installer.
   b. Floor box shall meet latest UL standards for scrub water resistance
   c. Four-Compartment Combination Box similar to Wiremold RBF4 or Wiremold RFB6
   d. Top of box shall allow for matching floor finish insert and be constructed of metal
   e. Provide all brackets and accessories for proper telecommunications installation.
2. Large Capacity In-floor box
   a. Wiremold Evolution Series with flush mounted cover.
3. Poke through
   a. Unit shall be similar to Wiremold Evolution Series with 5 gangs

I. Distribution Backboard

1. Plywood

a. ¾" AC-grade plywood shall be provided as shown on T drawing details to line the walls within the TR. The plywood should be provided in 4' x 8' sheets.

b. Plywood shall be void free and painted on all sides with two coats of fire-resistant paint.

J. Electrical Protection for Telecommunications

1. Telecommunications Main Grounding Busbar (TMGB) and Telecommunications Grounding Busbar (TGB)

a. Provide one TMGB in the Telecommunications Equipment Room as shown on T Drawings.

b. Provide a TGB in every Telecommunications Room and distribution cabinet location as shown on T Drawings.

c. The telecom grounding and bonding system shall be bonded to the main electrical ground for the facility.

K. Rack mounted power strip

1. Provide 8 port transient, surge protection strip (UL Listed) for each rack or cabinet.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions

1. Contractor shall ensure that sufficient space has been allocated for the installation of all equipment per T Drawings prior to Installation. Clearances and existing equipment should be taken into consideration. If insufficient space exists, the Design consultant should be notified in writing, before proceeding with Installation.

3.2 INSTALLATION

A. Distribution Racks and Cabinets

1. Racks shall be assembled such that mounting rails are exactly perpendicular to the base.

2. Racks shall be secured to the floor using appropriate anchors.

3. Racks shall be grounded to the TGB or appropriate building ground using a minimum #6 grounding wire.

B. Distribution Backboard

1. Securely fasten backboard to wall-framing members to ensure it can support attached equipment.

2. Mount plywood on all available areas where telecommunications equipment may be located.

3. Refer to T Drawings for minimum coverage.

C. Ladder Rack and Cable Tray

1. Ladder rack and cable tray shall be properly secured using manufacturer recommended anchors and connectors.

2. Ladder rack and cable tray shall be routed according to T Drawing floor plans.

3. Ladder rack and cable tray shall be bonded to ground according to TIA/EIA 607.

D. Firestop

1. Provide re-enterable, non-hardening, intumescent putty, rated for floors or wall, UL approved assembly, with approved packing material for fire stopping inside building cable penetrations thru conduits sleeves.

2. The material used for sealing all openings shall have a fire rating equal to or greater than the floor ceiling, wall or partition material.

E. Sleeves and openings

1. The telecommunications contractor shall provide sleeves through all walls and floors to protect cabling and or raceways installed as part of the telecommunications system. All sleeves shall extend through the respective wall or partition and finish with a connector protective bushing.

2. Sleeves through all fire rated structures shall have appropriate fire stop system.

END OF SECTION

SECTION 27 41 00 - AUDIO VISUAL AND SOUND SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Audio / Visual systems for the aux gym and gymnasium.

1.2 DEFINITIONS

A. "Communications Network Outlet (CNO)" refers to a collection of one or more mechanical cable termination device for horizontal cable in the work area.
B. "Drop" refers to the vertical transition to a location of one or more CNOs.
C. "Horizontal Cabling" refers to the cabling between and including the work area communications network outlet and the horizontal cross-connect in the telecommunications room.
D. "Jack" refers to a female-style telecommunication receptacle.

1.3 SYSTEM DESCRIPTION

A. Design Requirements

   1. Auxiliary Sound/Video Systems

      a. Gymnasium Sound Reinforcement System - A multi-loudspeaker system shall be provided. Clearly label and color code the master volume control for all functions.

      b. Gymnasium Sound Reinforcement System - A multi-loudspeaker system shall be provided. Clearly label and color code the master volume control for all functions.

      c. Hearing Assistance System - Provide a reinforcement system for the hearing impaired in the Gymnasiums and Cafeteria. The hearing assistance system shall be an FM radio system that shall not limit operation to certain seats or areas of the room(s). Provide approximately 20-40 milliseconds of high-quality digital signal delay to help in the localization of the sound source.

   2. All stand alone sound systems must have call override from the Intercom/PA system in the case of an emergency.

B. Performance Requirements

   1. Comply with applicable requirements in Local, State and Federal Codes, TIA/EIA Standards, and BICSI methodology.

   2. Specified cabling system derived from recommendations in approved telecommunications industry codes, standards and methods, including the following documents:

      a. Articles 250, 725, 760, 770, 800,810 and 820 of the current National Electrical Code.

      b. ANSI/TIA/EIA-568-B.1: Commercial Building Telecommunications Cabling Standard Part 1 – General Requirements

      c. ANSI/TIA/EIA-569-A: Commercial Building Standard for Telecommunications Pathways and Spaces

      d. ANSI/TIA/EIA-606: Administration Standard for Telecommunications Infrastructure of Commercial Buildings

e. BICSI Telecommunications Distribution Methods Manual (TDMM), Latest Edition

f. National Fire Protection Agency (NFPA-70): National Electrical Code (NEC)

1.4 SUBMITTALS

A. Comply with requirements of Division 0 and Division 1 - Submittals and as modified below.

B. Product Data: Submit manufacturer's product literature, technical specifications and similar information for the following items demonstrating compliance with the specified requirements.

1. Sound coverage and pressure level diagram for each auxiliary sound system
2. Sound Amplifier
3. Sound Speakers
4. Sound Microphones
5. Sound Cabling and Wiring
6. Audio Visual cables and connectors
7. DSP Units
8. A/V switchers
9. A/V controllers
10. Signal Extenders
11. A/V Mixers
12. Communications outlets, faceplates, and accessories.
13. Wall outlets

C. Samples: Provide samples of equipment, cables, microphones and assemblies as described below, prior to installation, for approval by designer.

1. Sound Enhancement – Submit samples of audio visual cables provided including following components and characteristics:

a. Sample characteristics:

i. Provide all components in colors selected by Design consultant.

ii. Provide multiple samples where required to accurately represent range of cables to be provided.

D. The Contractor shall submit line drawings of all systems showing major components of the systems. Submit wiring diagrams showing connections for all systems and equipment.

E. Submit floor plan drawings clearly indicating all equipment and locations of equipment.

F. Quality Control Submittal

1. Test Reports: Submit complete sample test data and reports with exact labels used on cables and faceplates.
2. Certificates

a. Manufacturer Certification: Submit certification from manufacturer of products to be installed under this contract certifying that Installer is authorized by manufacturer to install specified products.

b. Installer Experience Listing: Submit list of at least 5 completed projects as specified below in “Quality Assurance – Qualifications – Installer.”

G. Contract Closeout Submittal: Comply with requirements of Division 0, including submission of operating and maintenance instructions as item in “Operation and Maintenance Data” manual described in that Section.

1.5 QUALITY ASSURANCE

A. All Work shall be installed in a first class, neat and professional manner by skilled Technicians. The quality of the workmanship shall be subject to inspection and approval by authorized school district personnel. Any work found to be of inferior quality and/or workmanship shall be replaced and/or reworked until the approval of the school district is obtained.

B. Installer Qualifications: Qualified to cable, terminate and test cabling system specified in this Section, certified by manufacturer of products to be installed, and completed at least 5 installations of similar size, nature and complexity as specified for this project.

C. Conditions for Consideration of "Or Equal" Products: Where products are specified by name and accompanied by the term "or equal”, the proposed "or equal" product will be considered when the following conditions are satisfied. If all the following conditions are not satisfied, Design Consultant will return requests without action, except to record noncompliance with these requirements:

1. Proposed product does not require extensive revisions to the Contract Documents.
2. With the exception of the product name or number and manufacturer's name, proposed product conforms with requirements indicated on the Drawings and in the Specifications in every respect and will produce indicated results.
3. Proposed product is fully documented and properly submitted.
4. Proposed product has received necessary approvals of authorities having jurisdiction.
5. Proposed product is compatible with AND has been coordinated with other portions of the Work.
6. Proposed product provides specified warranty.
7. If proposed product involves more than one contractor, proposed product 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.
8. Submission is accompanied with 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.
9. Submission is accompanied with a list of similar installations for completed projects with project names and addresses and names and addresses of design consultants and authorities, if requested.
10. Submission is accompanied with proposed product's Manufacturer signed written statement on Manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents.

1.6 WARRANTY

A. Installer’s Warranty: Provide manufacturer’s system warranty against electrical or mechanical defects for 1 year from date of final acceptance.

1. System Certification: Upon successful completion of the installation and subsequent inspection, the Authority shall be provided with a numbered certificate, from the manufacturing company, registering the installation.

PART 2 - PRODUCTS

2.1 MATERIALS – ALL MATERIALS SHALL BE NEW AND UNUSED

A. Acceptable Products

1. The Auxiliary Sound Systems are based on Rane, Extron, Community, Biamp, Sennheiser, Shure, Lowell and other like reputable manufacturers.

    a. Equipment substitutions must be submitted in writing to the design team for review and approval.

    b. Any equipment not meeting the design criteria will be rejected at the contractor's expense.

B. Aux Gymnasium Sound System

1. Equipment Cabinet

    a. Middle Atlantic SR-40-32 Wall Mounted Swing Cabinet

2. Intercom Shunt

    a. Bogen VAR1

3. Mixer

    a. Peavery SMR821a

4. DSP

    a. Biamp Nexia SP

5. Amplifier

    a. QSC RMS 1850 HD

6. Assistive Listening

    a. Listen Technologies LS-03 Kit

7. Loudspeakers

    a. EV SX100

8. Wireless Mics

    a. Shure SLX124/85/sm58

9. DVD/CD Player

    a. Denon DN-300z

10. Auxiliary Input Switcher

    a. RDL EZ-HSX4

11. Power Conditioner

a. Atlas ECS-3

12. Equipment Drawer

a. Atlas SD4-14 Drawer

13. UPS Equipment

a. APC 3000 120 VAC Smart Ups

14. Mic Level Input

a. Neutrik 1/4” XLR Combo

15. Line Level Input

a. Neutrik Connector

16. Stereo Input

a. Neutrik ¼” XLR Combo

17. Wired Microphone

a. Shure SM58S

18. Podium Microphone

a. Shure MX 412/C Gooseneck Podium Microphone

19. Microphone Stands

a. Atlas TEB-E

20. Wiring

a. Shielded Cat 5e or greater UTP for audio faceplate cables.

b. West Penn 226, or equal, for the loudspeaker cluster circuits.

21. Miscellaneous Connectors

a. Provide Neutrik NC3 series “XLR”, Neutrik NP3C “TRS” or Canare F-09 “RCA” connectors.

b. Provide Switchcraft N112B connectors.

c. Provide crimped or gas-tight terminals for all loudspeaker connections. Wirenuts are not acceptable.

C. Main Gymnasium Sound System

1. Equipment Cabinet

a. Lowell LER-3522

b. Or approved equal.

2. Amplifiers

a. QSC CMX 800V

b. Or approved equal

3. Power conditioners/sequencers
    a. Atlas ECS-3
    b. Lowell SCS8R-ASM
    c. Or approved equal.
4. Mixers
    a. Peavey SMR
    b. Or approved equal
5. DSP
    a. Biamp Nexia SP
    b. Or approved equal.
6. Speakers
    a. Community R.5-99TZ
    b. Community R.5SUB-T
    c. Or approved equals.
7. Wireless Equipment
    a. Shure SLX124/85/sm58
    b. Or approved equal
8. Assistive Listening Equipment
    a. Listen Technologies LS-03
    b. Or approved equal.
9. CD Player
    a. Denon DN-300Z
    b. Or approved equal
10. IPod Dock
    a. Chief NA1B
11. Portable Mixer
    a. Mackie DFX6
    b. Or approve equal.
12. Intercom Shunt Relay
    a. RDL TX-70A

b. RDL ST-ACR2

c. Or approve equal

13. Remote Control

a. Universal Remote Control MSC-400

b. Universal Remote Control RFX-250 RF Receiver

c. Universal Remote Control MX5000

d. Or approved equal

14. Connectors

a. Neutrik XLR TRS.

b. Or approved equal

15. Microphones

a. Shure Cardoid Type hand held microphones

b. Or approved equal

16. Microphone Stands

a. Shure

17. Cables

a. Balanced Audio Cables

b. Unbalanced Audio Cables

c. Provide West Penn 291, or equal, for all microphone jack, line jacks and remote volume control locations, and for all line level wiring. Color code wires for separate functions (e.g. blue=microphone, violet=line level, green=volume).

d. Provide West Penn 226, or equal, for the Gymnasium/Auditorium loudspeaker cluster circuits.

e. Provide West Penn 225, or equal, for the Cafeteria loudspeaker circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which AV cabling and sound enhancement equipment and related components are to be installed in coordination with Installer of materials and components specified in this Section and notify affected Prime Contractors and Design consultant in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected to ensure a safe and timely installation.

1. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Design consultant written confirmation from applicable Installer. Failure to submit written

confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

2. Visit Site to identify and become familiar with existing field conditions and specific requirements of each Site.
3. Verify all dimensions in field and confirm condition of existing hardware to be utilized.
4. Confirm space requirements and physical confines of all work areas to ensure that all materials can be installed in indicated spaces.
5. Confirm all outlet locations and cable pathways and advise Design consultant in writing of any discrepancies or issues in Design described in Contract Documents.

3.2 PREPARATION

A. Protection: Provide adequate protection of equipment and hardware before and after installation.
B. Existing Communications Services: Ensure all telecommunications systems (voice, video and data) remain operational throughout the project.

1. Identify any additional outlets, circuits, and wiring at the site not shown on T-Drawings and interfering with installation of specified equipment.
2. Remove all accessible portions of abandoned communications cabling per NEC 800.52. Tag all communications cabling not terminated at both ends but retained for future use.

3.3 INSTALLATION

A. Provide and install all components necessary to install complete AV cabling and sound enhancement equipment systems, including (but is not limited to) connectors, electronics, terminators, pass-thrus, cables etc…

1. Cable runs shall be factory terminated. Splicing of any cable is prohibited
2. Secure all cables within ceiling cavities to building structure.
3. Loosely bundle all cables and support from structure at unequal intervals from 5 to 6 feet with spring steel fasteners and cable clip rated for use with high performance cables where cable tray or other support structure has not been provided as indicated on Drawings. All mounting clips shall be seismic type as per BOCA.
4. Do not violate manufacturer’s recommended loadings. Leave 30% capacity for future use of pathway.
5. Verify all horizontal cable run lengths prior to installation. Ensure cables do not exceed distances that would degrade the signal transmission requirements
6. Do not support cables from ceiling grid T-Bars, grid wire supports or bridle rings. Do not allow cables to touch ceiling grid.
7. Install cables in EMT in all unfinished or exposed areas
8. Do not secure cables with permanent cable ties. Do not tighten cable bundles in such a way as to cause jacket deformation or damage.
9. Place cables in compliance with TIA/EIA-568.B standards and BICSI recommended methods.

10. Tight 90-degree bends are unacceptable, and use of plastic “cinch-type” tie-wraps are not permitted, in order to prevent damage to cable jacket and compromise the cable’s electrical or optical characteristics.

11. Communications outlets shall be located to be no more than 6 feet from an electrical outlet.

B. Determine allowable cable proximity to other electrical power sources of 480 Volts or less using TIA/EIA-569A “Cabling Pathway Standard” for UTP cable separations from sources of EMI:

1. Minimum separation distance from Power Source at 480 V or less:

CONDITION	< 2kVA	2-5 Kva	> 5 kVA
a. Unshielded power lines or electrical equipment in proximity to open or non-metal pathways	6 in.	12 in.	24 in.
b. Unshielded power lines or electrical equipment in proximity to open or non-metal pathways	3 in.	6 in.	12 in.
c. Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to grounded metal conduit pathway	3 in.	6 in.	12 in.
d. Transformers & Elec. Motors	40 in.	40 in.	40 in.
e. Fluorescent Lighting	12 in.	12 in.	12 in.

C. Install all cable in accordance with National, state and local codes and TIA/EIA Standards, and BICSI methods.

1. Follow manufacturer’s guidelines and requirements for all cable termination.

D. Permanently identify all system components following TIA/EIA-606A “Administration Standard for Commercial Telecommunications Infrastructure” with identification format:

1. Identification: Provide permanent identification labels for outlets, faceplates and cables.

2. Each individual cable shall be labeled on both ends of cable terminations regardless of cable intended use. Labels must be machine printed with permanent black ink on laminated white label material. Contractors must check with appropriate school district personnel for appropriate labeling scheme. The intended format and labeling material must be approved by the school district Technology Department before labeling begins.

3.4 TESTING

A. Audio Visual Harness

1. The contractor shall test all cables included in the harness for proper signal transmission based on manufacturer standards.

2. The contractor shall record remove any cable that does not meet manufacturer standards and replace it with a correctly functioning cable.

3. The contractor shall demonstrate that the installed cables meet manufacturer standards for signal transmission prior to the job being considered complete.

B. Sound Enhancement System

1. The contractor shall test all aspects of the sound enhancement amp/mixer once it is installed and demonstrate these functions to the owner of owner's representative.

    a. Speaker levels shall be verified to function individually and as a unit

    b. Microphones shall be demonstrated to work as intended by the manufacturer.

3.5 ACCEPTANCE

A. Contractors work shall be considered complete after the following conditions have been met:

1. Cable installation is complete and all cable runs have been tested and documented to be installed according to specifications and drawings.
2. Equipment installation is complete and all functions have been tested and documented to function as designed and per the manufacturer's recommendations.
3. All punch list items have been reconciled.
4. All disturbed ceiling panels, fire stopping materials, covers, etc. have been properly reinstalled.
5. All materials and trash have been removed from the site.
6. A 1-Year Installers warranty has been given to a school district Technology representative.
7. Submit Manufacturers Extended Warranty Application.

END OF SECTION

SECTION 27 50 00 – INTERCOM AND CLOCKS

PART 1 - GENERAL

1.1 SUMMARYS

A. Section Includes
1. This section and associated drawings define a communications system for an intercom, public address and master clock system. The contractor shall provide all infrastructure, cable, hardware and equipment as defined to provide complete and operational systems.

1.2 SYSTEM DESCRIPTION

A. Design Requirements
1. Intercom/PA/Master Clock System
a. The facility intercommunication system shall be a low voltage system that utilizes a fiber and copper cable infrastructure to distribute a user-defined input in a single or bi-directional manner. The system shall be capable of multiple, simultaneous conversations on separate channels throughout the facility through telephones and loudspeaker assemblies.
b. A programmable master for tone distribution schedule shall also be included as part of the overall system.
c. The system shall be microprocessor based and have interconnection with the telephone system installed within the facility. In addition, the system must be expandable to meet the user's future expansion needs and be programmable from a computer terminal located at the facility.
d. The clock system shall consist of a master unit and slave clocks. The system shall be wireless and have battery powered clocks. All clocks shall be corrected wirelessly to the master clock system.

B. Performance Requirements
1. Rack/Cabinet mountable headend equipment.
2. Announcement distribution from a central location to zones, individual classrooms, groups or all facility speakers.
3. Broadcast of user defined input (radio signal, compact disc, aux input, etc.) to zones, individual rooms, groups or all facility loudspeakers.
4. Emergency cut-in to all speakers in an emergency situation from a central location.
5. Two-way intercommunication between the central rack, any call-in location or any selected two-way speaker location.
6. Hands free communications by means of a loudspeaker or speakerphone used as a transducer or speaker/microphone combination.
7. Visual and audio monitoring of all intercommunication system activity.
8. Volume and level controls for all centrally located intercommunication system equipment.
9. Tone distribution based off the master clock that can be partitioned into zones.
10. Capability to tie into any auxiliary sound system throughout the facility.
11. High priority call-in from any telephone/call switch in an emergency situation.

C. Regulatory requirements
1. All work will conform to the National Electric Code and applicable local ordinances.

1.3 SUBMITTALS

A. Comply with requirements of Division 0 and Division 1 - Submittals and as modified below.

B. Product Data: Submit manufacturer's product literature, technical specifications and similar information for the following items demonstrating compliance with the specified requirements.
   1. Submit the shop drawings, product data and quality control submittals specified below at the same time as the package
   2. Shop Drawings shall include the following items but are not limited to:
      a. Equipment and device quantities and types
      b. Wire types
      c. System wiring diagrams showing all connections
      d. Drawings including all equipment locations
      e. Associated equipment specifications and cut sheets
      f. Product data including catalog cut sheets, manufacturer's default specifications, user operation guides and a bill of materials

C. Quality Control Submittal
   1. Submit the name, address and telephone number of the nearest fully equipped service organization.
   2. Submit a certificate of completion of installation and service training from the system manufacturer.
   3. Certificates
      a. Manufacturer Certification: Submit certification from manufacturer of products to be installed under this contract certifying that Installer is authorized by manufacturer to install specified products.
      b. Installer Experience Listing: Submit list of at least 5 completed projects as specified below in "Quality Assurance – Qualifications – Installer."

D. Contract Closeout Submittal: Comply with requirements of Division 0, including submission of operating and maintenance instructions as item in "Operation and Maintenance Data" manual described in that Section.

1.4 AS-BUILTS

A. All systems must have as-built drawings provided in electronic CAD and hardcopy format that clearly show all system components, wiring schemes and system interconnections.

1.5 QUALITY ASSURANCE

A. All Work shall be installed in a first class, neat and workmanlike manner by skilled Technicians. The quality of the workmanship shall be subject to inspection and approval by authorized school personnel. Any work found to be of inferior quality and/or workmanship shall be replaced and/or reworked until the approval of the school systems is obtained.

B. Qualifications
   1. Installer
      a. Must be qualified to cable, terminate, install and program the equipment specified in this Section, certified by manufacturer of products to be installed, and completed at least 5 installations of similar size, nature and complexity as specified for this project.

1.6 WARRANTY

A. Special Warranty: Provide manufacturer's system warranty against electrical or mechanical defects for 1 year from date of final acceptance.

1. System Assurance: The System Assurance shall cover the failure of the wiring system to support the application which it was designed to support as well as additional application(s) introduced in the future by recognized standards or user forums
2. System Certification: Upon successful completion of the installation and subsequent inspection, the Authority shall be provided with a numbered certificate, from the manufacturing company, registering the installation.

1.7 TRAINING

A. Installing contractor shall provide a minimum of 8 hours of training on system operation and managements as part of their scope of work.
   1. Additional hours shall be provided on a time and materials basis at the request of the owner.

B. Installing contractor shall provide a video recording on a standard format DVD to the owner which includes training sessions.

1.8 OPERATION AND MAINTENANCE MANUALS

A. Installing contractor shall provide a minimum of two hardcopy and one electronic copy of all operation and maintenance manuals to the owner at project completion.

B. All passwords and software must be included for the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers
   1. The intercom and clock systems shall be manufactured by a reputable manufacturer with a proper support and maintenance operation in place.
      a. Intercom Basis of Design - Bogen
      b. Clock Basis of Design - Bogen

2.2 MATERIALS

A. CONSOLE
   1. Rack-mounted equipment shall be Bogen Model TCPER
      a. 77” Rack

B. MCRMP / MCMP / QRC24-48 (Compact Rack System)
   1. Rack Mount full, Mini-System, or Wall Mount panel. Shall include the following components:
      a. Quantum Processor Card QSPC1
      b. Analog Card
      c. Station Card
      d. Telephone Interface Card
      e. 5 volt / 12 volt Power Supply
      f. 26 volt Power Supply(s)
      g. Audio Program Module Interface Assembly

C. MCRMF / MCMF / QRC24-48
   1. MCRMF Rack mounting mainframe. Includes built-in ventilation fans and the following circuit cards:
      a. Quantum Processor Card
      b. Analog Card

c. Station Card
d. Telephone Interface Card
e. Ribbon Cable Assembly

2. MCF Wall Mount mounting mainframe. Utilizes convection cooling and the following circuit cards:
   a. Quantum Processor Card
   b. Analog Card
   c. Station Card
   d. Telephone Interface Card
3. QCR24 / QCR48 Compact Quantum Rack System Mainframe (1 per Mini-System). Includes built-in ventilation fan and the following circuit cards:
   a. Quantum Processor Card
   b. Analog Card
   c. Station Card
   d. Telephone Interface Card

D. MCRRP / MCRRC / MCRC
   1. Relay Module/Card

E. MCRCA
   1. Ribbon Cable Assemblies

F. Program Sources
   1. Tape Player & AM/FM Tuner
   2. 5-Disc CD Player
   3. AM/FM Tuner
   4. Desktop Paging Microphone

G. Power Amplifiers
   1. 60-Watt Amplifier
   2. 125-Watt Amplifier
   3. 250-Watt Amplifier

H. Station Equipment
   1. Administrative Display Phone
   2. Administrative VoIP Phone
   3. Administrative Wall-Mount Phone
   4. Administrative Desktop Phone
   5. Secure Call - Call Assurance Call-in Switch
   6. Call switch with Privacy
   7. Rocker-style Call Switch

I. Optional Equipment
   1. Telephone Access Card
   2. Telemedia Control Unit
   3. Television Control Unit
   4. Handheld Infrared Transmitter

J. Administrative Phone
   1. Admin phones shall be one of the following Bogen Model(s)
      a. MCDS4 – Administrative Display Phone
      b. QSIP1 – Administrative VoIP Phone (Desk or Wall)

K. Call Staff Stations
   1. Staff Stations shall be Bogen Model:

a. SC1 – Secure Call - Call Assurance Call-in Switch
b. CA21B – Call Switch with Privacy

L. Intercom System Speakers
1. Classroom Speakers shall be Bogen:
a. Drop-in Ceiling Speakers: CSD2X2VR/U Drop-In Ceiling Speakers
b. Cut-in Ceiling Speakers: S86T725PG8U
c. Wall Speakers: MB8TSQ/SL Metal Box Speakers
2. Hallway Speakers shall be Bogen:
a. Ceiling Speakers: CSD2X2VR/U Drop-In Ceiling Speakers
b. Cut-in Ceiling Speakers: S86T725PG8U
c. Wall Speakers: MB8TSQ/SL Metal Box Speakers
3. Outdoor / Gym / Locker Room Speakers shall be Atlas Sound:
a. Atlas Sound VTF-157UCN or similar
4. Common Area Speakers shall be Bogen:
a. HFCS1 High-Fidelity Ceiling Speakers
b. OCS1 NEAR Orbit Ceiling Speakers
c. OPS1 NEAR Orbit Pendent Speakers

M. Master Clock
1. The system shall be Bogen BCMA 3000 Wireless Clock system.
2. The system shall provide for automatic clock correction for Daylight Savings Time, Spring Ahead/Fall Back. Daylight savings shall not require the use of any user input at the time of daylight savings.
3. The master clock system shall support a minimum of 16 schedules and 1536 events as outlined in the Intercom/PA Features section.
4. The system shall support Electronic Message Displays. These displays are integral to the emergency notification needs of the facility.
5. In the event of an Emergency Call from a classroom, the origin of the Emergency Call is displayed on multiple Electronic Message Displays, giving the opportunity for school staff to respond more quickly. In addition, a console or room telephone has the ability to activate a specific message for display on a group of EMDs. This allows an emergency procedure such as school “lock down” to be activated from any telephone, quickly and efficiently.

N. Clocks
1. Clocks shall be Bogen BCAL-2 battery powered, wirelessly corrected clocks in 12” and 16” surface, round with battery booster.
a. All clocks shall be corrected via RF.

O. Accessories
1. Bogen 1000 Wireless Repeater.
2. Bogen Wireguard.

P. Corridor Clocks
1. Double faced Slave clock where indicated from Bogen

2.3 WIRING

A. Cable and Jacks
1. Headend to Call Switches shall be West Penn 25359B Plenum Rated Wire. Red/Black to speakers, Green/White to call switches.
2. PA Cable shall be plenum rated.
3. PA Cable shall be yellow or approved equal.

4. Hallway and exterior speaker runs shall utilize West Penn 25292B Plenum rated cable with no more than 10A per circuit.
5. PA Cable must be presented to the school district Maintenance and Electrical Department for approval prior to installation.

B. SPARE CAPACITY/SYSTEM EXPANSION
1. The contractor shall include extra circuits for staff telephones and loudspeakers built into the system for future expansion. Contractor shall provide and install fifteen percent (25%) extra circuitry (line cards, expanders, etc.) for these devices. The Owner shall add only field instruments (telephones and loudspeakers), cabling, and programming to make these extra capacity circuits fully operational.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which telecommunications cabling and equipment and related components are to be installed in coordination with Installer of materials and components specified in this Section and notify affected Prime Contractors and Design consultant in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected to ensure a safe and timely installation.
1. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Design consultant written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.
2. Visit Site to identify and become familiar with existing field conditions and specific requirements of each Site.
3. Verify all dimensions in field and confirm condition of existing hardware to be utilized.
4. Confirm space requirements and physical confines of all work areas to ensure that all materials can be installed in indicated spaces.
5. Confirm all device locations and cable pathways and advise Design consultant in writing of any discrepancies or issues in Design described in Contract Documents.

3.2 PREPARATION

A. Protection: Provide adequate protection of equipment and hardware before and after installation.

B. Existing Communications Services: Ensure all telecommunications systems (voice, video and data) remain operational throughout the project.
1. Identify any additional intercom equipment, devices, and wiring at the site not shown on T-Drawings and interfering with installation of specified equipment.
2. Remove all accessible portions of abandoned communications cabling per NEC 800.52. Tag all communications cabling not terminated at both ends but retained for future use.

3.3 INSTALLATION

A. Provide and install all components necessary to install complete intercom/PA/master clock system, including (but is not limited to) cable, connectors, patch panels, call switches, speakers, etc…

B. Secure all horizontal cables within ceiling cavities to building structure.
   1. Loosely bundle all cables and support from structure at unequal intervals from 5 to 6 feet with spring steel fasteners and cable clip rated for use with high performance cables (similar to Caddy Series "CableCat" or approved alternate mounting methods) including placement in cable tray as indicated on Drawings. All mounting clips shall be seismic type as per BOCA.
   2. Do not violate manufacturer's recommended loadings. Leave 30% capacity for future use of pathway.
   3. Verify all horizontal cable run lengths prior to installation. Re-distribute horizontal cabling to maintain distance requirements and maintain pathway route accessibility.
   4. Do not support cables from ceiling grid T-Bars, grid wire supports or bridle rings.
   5. Do not allow cables to touch ceiling grid.
   6. Install cables in EMT conduit in all unfinished, exposed areas as shown in Design consultant roof plans and/or T-Drawings, unless alternate pathways are noted.
   7. Do not secure cables with permanent cable ties. Do not tighten cable bundles in such a way as to cause jacket deformation or damage.
   8. Place cables in compliance with TIA/EIA-568.B standards and BICSI recommended methods.
   9. Re-terminate and re-test any cables or pairs of cables failing end-to-end testing requirements. Replace any faulty cables/pairs or termination devices. Remove all defective cables completely from pathways.

C. Install all exposed cabling in surface raceway by Wiremold, Hubbell or Panduit where in-wall conduit has not been provided. Follow all manufacturers' guidelines requirements regarding bending radius and slack. All bends, offsets and fittings shall be appropriately sized to provide 30% capacity after installation.

D. Install all cable in accordance with National, state and local codes and TIA/EIA Standards, and BICSI methods.
   1. Follow manufacturer's guidelines and requirements for all cable termination.
   2. Follow detail drawings to locate equipment racks and cabinets. Where it is necessary to deviate, to obtain 30-inch clearance between equipment, obtain Design consultant's written approval before mounting cabinet/rack.
   3. Ladder-type cable tray shall be affixed 6 inches above all data racks and equipment cabinets, and routed to all points of entry into each telecommunications room.
      a. Include transition to proper height for penetration into hallway or other wall penetration as indicated on Drawings.
      b. Install sufficient 4-inch conduits from telecom rooms into hallway (minimum of 2) with protective insulating bushings, cable spillway or specially designed cable tray sections, with appropriate firestop materials.

E. Properly terminate all cables at speakers, call switches, administrative consoles and distribution racks. Permanently identify all cables in pullboxes, transition points, and termination points by affixing pre-marked self-adhesive wraps similar to Brady "B-500+ Plastic Cloth Markers."

F. Permanently identify all system components following TIA/EIA-606A "Administration Standard for Commercial Telecommunications Infrastructure" with identification format:
   1. Identification: Provide permanent identification labels for end devices and associated cabling at each end.

END OF SECTION

SECTION 28 10 00 - ACCESS CONTROL AND INTRUSION DETECTION

PART 1 GENERAL

1.1 REQUIREMENTS

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.2 SUMMARY

A. Provide a complete and fully operational Access Control System (ACS) and Intrusion Detection System (IDS) as described herein and the contract drawings.

B. The access control system and intrusion detection system shall be coordinated between installers providing door hardware, power sources and electronics.

C. Provide a Door Entry Video/Audio System complete with door controls, video monitors, intercom communications and expansion ports.

1.3 RELATED SECTIONS

A. Door Hardware (by others)

B. Electrical (by others)

1.4 SYSTEM DESCRIPTION

A. Design Requirements
   1. The Access Control system shall consist of the following:
      a) Communication Modules
      b) Door Controllers
      c) Access Control Card Readers
      d) Access Control Access Cards
   2. The Intrusion Detection System shall consist of the following
      a) Headend Panels
      b) Motion Detectors and Door Contacts
      c) Associated Cabling
      d) Communications Modules
   3. The Door Entry System shall consist of the following
      a) Video Intercom Stations
      b) Interior Handset Locations
      c) Door Controllers
      d) Door Locks
      e) Power Supply
      f) Cables.

B. Performance Requirements
   1. The ACS and IDS shall be controllable remotely and onsite to allow or prevent access to certain areas of the facility. Access shall be programmable by user type.
   2. Each end point shall be able to be monitored and controlled individually.
   3. The system shall produce a signal (both visual and audible) if the system is breached by an unauthorized user.
   4. The systems will be capable of communicating onsite as well as to remote locations.

5. The systems shall be controllable in case of emergency situation.
6. The ACS and IDS shall be interfaced with the Fire Alarm system at the facility to allow egress in the case of a fire emergency.
7. Specific Exterior doors shall be equipped with Access Control equipment and Intrusion Detection Equipment.
8. Specific interior doors shall be equipped with Access Control Equipment and Intrusion Detection Equipment
9. The Access Control System must provide fail safe operation to disengage with a loss of power.
10. Specific locations shall have door contacts and motion detection as shown on the technology drawings
11. All equipment must be compatible with the existing owner equipment.
12. Request to Exit sensors shall be provided where required to allow of simple egress and alarm shunt.
13. The door entry system shall allow for visual two-way communications from a main entry door to the reception area. The system shall allow or disallow entry based on operator input. The system shall not interfere with other door hardware.

1.5 SUBMITTALS

A. Product Data
   1. Shop Drawings with a detailed riser detail shall be provided. Device locations as well as cable paths will also be provided.
   2. Cut sheets with exact model of equipment and parts clearly highlighted for review by the design team. Failure to do so will result in an immediate rejection.

B. Quality Assurance/Controls Submittals
   1. Design Data for the system shall be submitted with the proposed submittals.
   2. Upon completion of the installation, test reports shall be submitted to verify that the system is fully operational and functioning properly.
   3. Certificates of designer and installer shall be submitted with job submittals.
   4. Manufacturer’s Instructions shall be followed and incorporated in the design of the system.

C. As-Builts
   1. As-Built drawings shall be supplied in AutoCad 2007 or later format and duplicate hardcopy format once the system has been installed completely.
   2. As-builts shall include the attached Intrusion table filled out with the system configuration.

1.6 QUALITY ASSURANCE

A. A manufacturer’s authorized distributor and installation contractor for the specified system shall install the security intrusion detection system. The installation shall include wiring, components, connections, adjustments, testing and certification. The Electrical Trade shall provide conduit, junction boxes and pull boxes as indicated and required by the security access control system manufacturer’s drawings or trade instructions.

B. Regulatory Requirements
   1. All equipment and materials for this system shall be listed by Underwriter's Laboratories, Inc. (UL), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), all state and local codes, and these Specifications.
   2. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.

C. The security intrusion detection system contractor shall furnish a list of similar or equal installations and demonstrate five (5) years certifiable experience in this type of work.

1.7 WARRANTY

A. The access control system and intrusion detection system shall be under warranty for a period of two (2) years upon the acceptance of the owner.

1.8 MAINTENANCE

A. This contractor shall coordinate with owner prior to bidding and award to determine the acceptable quantities of spare parts.

B. Upon the completion of the factory two (2) year warranty, a maintenance contract will be negotiated between the access control system trade and the owner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ACS and IDS Basis of Design
   1. DSC
   2. Other Acceptable Manufacturers:
      a) Honeywell

B. Door Entry Basis of Design
   1. Aiphone

C. All components and equipment must be compatible with the entire system and be new and unused.

2.2 EQUIPMENT

A. The access control system basis-of-design manufacturer is DSC (Tyco Security Products), with Honeywell as an approved equal.
B. Bosch security products will not be specified.
C. ACS and IDS Parts
   1. DSC SD2002SA Software System Package
   2. DSC Maxsys PC4020 Control Panel
      a) 16 zones on main control panel
      b) Supports up to 16 hardwired keypads
      c) Expandable up to 128 zones using hardwire, wireless modules and addressable zones
      d) COMBUS hardwired expansion
      e) 8 partitions
      f) 1,500 user codes (4 or 6 digit)
      g) 3,000-event buffer
      h) 9 account and 3 phone numbers
      i) 1 supervised bell zone
      j) Built-in telephone line and siren supervision
      k) Auto SIA and Contact ID formats
      l) Supports GSM and T-Link™ alarm communicators
      m) Full upload/download support with DLS download software

n) Approval Listings: European CE Directives (EMC, R&TTE, LVD), INCERT (Belgium), FCC/IC, UL/ULC

3. DSC T-Link Universal IP Alarm Communicator TL300
4. DSC 2-Reader Module PC4820
5. DSC Remote Equipment Cabinet PC4053
6. HID Prox Card Reader 5365

D. Access Cards
1. HID Smart ISOProx II Cards
2. Provide 200 cards

E. Zone Expansion Modules
1. PC4108/PC4116

F. TCP/IP Interface
1. T-Link TL300

G. Door Controller
1. PC4820

H. Recessed Door Contacts
1. Sentrol 1076D Double Pole Contact:
2. Normally closed, magnetic reed switch
3. 120 V, 500mA, and minimum of 100,000 operations

I. Panic Buttons
1. EOLR on the last device within a zone
2. Shall have the work Emergency printed on the fascia
3. Sentrol 3040

J. Motion Detectors
1. Dual technology PIR detectors
2. Wide Range
   a) 90 degree pattern with look down
   b) 30’ minimum range.
3. Long range
   a) Minimum of 100’ distance
4. Overhead
   a) 360 degree field of view
5. Provide Maxsys model or approved equal

K. Request to Exit Devices
1. T-REX

L. Keypads
1. LCD4501

M. Power Supplies
1. Altronix Power Supplies with Yuasa rechargeable batteries, appropriately sized.
   a) Transformers: NFPA 70, Class II control transformers, NRTL listed. Transformers for security access control system will not be shared with any other system.
2. Cabling:
   a) Acceptable manufacturers: Belden, Berk-Tek, Coleman, General Cable Technologies, Mohawk/CDT, and West Penn Wire/CDT.

b) NFPA 70, Type CMP plenum rated per manufacturer's recommendations.
c) Cabling is to be adequately sized for the installed distance to devices.
d)

N. AIPHONES Parts
1. Main entrance video intercom and door release system is to be by Aiphone Corporation.
2. Master Station AIPHONE IS-IPMV
3. Sub Station AIPHONE IS-IPMV
4. Exterior Station IS-IPDVF
5. Control Unit AIPHONE IS-IPC
6. Expansion Unit AIPHONE IS-CCU
7. Selective door release adaptor RY-3DL.
8. 24 VDC power supply PS-2420UL.
9. Desk stand for video units MCW-2/A.
10. Chime extension speaker IER-2.
11. Cable:
a) 14/2 AWG, 16/2 & 18/2 AWG minimum, plenum rated. Follow manufacturer guidelines.
b) Cat 6 UTP

PART 3 EXECUTION

3.1 EXAMINATION

A. The access control and intrusion detection trade prior to installation of the systems shall verify site conditions.

3.2 INSTALLATION

A. This Contractor as directed by the equipment manufacturer shall make all low-voltage wiring and connections.

B. This Contractor shall label all access control and intrusion detection system junction boxes covers with the zone numbers contained therein.

C. This Contractor under the direct supervision of the Owner’s technical staff shall perform the installation and final connections of all components and wiring.

D. All horizontal low voltage field-wiring penetrations through new and/or existing walls shall be sleeved. Minimum sleeve size shall be 3/4 inch. All sleeves shall be bushed both sides.

E. Devices
1. All access control and intrusion system devices shall be installed as per the manufacture’s installation guides.

F. Field Wiring
1. All vertical low voltage field wiring shall be installed by this Contractor in 1/2-inch conduit and/or surface metal raceway as shown on the Drawings.
2. All horizontal, low voltage field wiring shall be run at right angles to the building structure.
3. All horizontal low voltage field wiring to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in 1/2-inch conduit.

Conduit is not required in areas designated on the Drawings as Electric/Communications rooms or closets.

4. All horizontal low voltage field wiring to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks to be dedicated to the wiring specified in this specification section.
5. All horizontal low voltage field wiring shall be installed below the roof/floor structural supports (joists, beams, girders, etc.) wiring installed between the structural supports mentioned above and the roof or floor deck will not be acceptable.
6. This Contractor with insulated crimp wire connections shall make all low voltage wiring terminations. All low voltage field-wiring interconnections shall be made in junction boxes. All junction box covers shall be stenciled for distinct identification.
7. All conduits, device mounting boxes, junction boxes, and line voltage wiring shall be furnished and installed by this Contractor.
8. All wiring shall be checked and tested by this Contractor to insure the system is free from grounds, opens, and shorts.

3.3 ADJUSTING

A. Devices shall be adjusted and calibrated once system is operational to ensure proper and full functionality of the system.

3.4 DEMONSTRATION

A. Furnish to the Owner's designated representative eight (8) hours of on-the-job technical service instructions in the operating, maintenance, and troubleshooting of the system.

Contact ID

ACCOUNT# Subscriber Name _____

CHOOSE ONE:

□ **ADDENDUM** TO A NEW SUBSCRIBER MONITORING AGREEMENT.
□ **CHANGE** TO DATA ON AN EXISTING SUBSCRIBER ACCOUNT.

NOTE: UNLESS OTHERWISE INDICATED, THE DEFAULT CALLBACK 0PTl0N FOR RESTORE IS **LOG ONLY**; **TROUBLE IS DEALER ONLY**.

FOR YOUR CONVENIENCE, PANEL PRINT OLITS ARE ACCEPTED. **HOWEVER**, PLEASE INDICATE CALLBACK OPTION. EXCLUSION OF THIS INFORMATION MAY DELAY THE PROCESSING OF A SUBSCRIBER MONITORING AGREEMENT. IF YOU HAVE ANY QUESTIONS, PLEASE CONTACT YOUR SALES REPRESENTATIVE.

PANEL: □ADEMCO □NAPCO □ Maxsys □APEX OTHER (SPECIFY)_____
PARTITIONED?: □ NO □ YES (DEFINE BELOW)

1	5
2	6
3	7
4	8

EVENT QUAL.	EVENT CODE	PARTITION	ZONE# USER#	ZONE DESCRIPTION / USER NAME	CALLBACK OPTION	Ax

END OF SECTION

SECTION 28 23 00 - VIDEO SURVEILLANCE SYSTEM

PART 1 GENERAL

1.01 REQUIREMENTS

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SUMMARY

A. Section includes a Video Surveillance System (CCTV) System as indicated on the T series drawings.
   1. Video surveillance cabling
   2. Video surveillance hardware, cameras and components
   3. Video Surveillance DVRs/NVRs
   4. Video Surveillance power supplies and ups equipment
   5. Video surveillance software and applications

1.03 REFERENCES

A. The complete installation, including additions and modifications, shall be in accordance with:
   1. National Electrical Code Article 800
   2. Minimum standards of Electronics Industries Association (ElA)
   3. Security Industry Association (SIA) guidelines

1.04 SYSTEM DESCRIPTION

A. Design Requirements
   1. Provide a complete DVR base CCTV system
      a) The CCTV system shall have recorders connected to the local area network.
      b) DVR and power supply equipment shall be located in telecommunications spaces.
      c) The CCTV system shall be connected to UPS equipment and on facility emergency backup power.
      d) CCD cameras with indicated enclosure, mounts and domes.
      e) DVR network viewing of live & recorded video
      f) Lenses, automatic iris lenses and lens controls
      g) Rack type cabinets, cabling and miscellaneous materials as required and specified herein, and in accordance with the applicable codes
   2. The CCTV system shall be designed to accommodate a 70+ camera system. Parts listed within this specification shall remain the same for the system; however, quantities of parts may change to correspond to the number of cameras. Refer to contract drawings for exact quantities of devices and locations.

B. Performance Requirements
   1. The CCTV System shall have the capability of real-time recording, viewing and playback simultaneously.
   2. Real-time video searching.
   3. Time and Data stamp
   4. PTZ control from a keyboard or via remote software.
   5. Video archiving
   6. Day/Night recording capabilities
   7. H.264 compression

8. Multiple frame rate recording from 1fps to 30 fps.
9. Access to the system via IP communications on the district LAN and WAN.
10. Multiple DVR units function as virtual unit.

1.05 SUBMITTALS

A. Shop Drawings
   1. The CCTV System contractor shall provide a one-line riser diagram indicating camera location, mounting type, cable type and length, cable route and conduit size and connections of system proposed.
   2. Furnish complete operating instructions, including schematic and wiring diagrams of the system, engineering data sheets on each component and complete servicing data including part numbers of the various components
   3. Locate all components on shop drawings and as-builts

B. Equipment Cut Sheets

   1. All equipment must be clearly labeled with exact quantities and parts specified for use on the job. Any equipment not clearly called out in product data submittals will be rejected without question and must be resubmitted at no cost to the owner.

C. As-Built Drawings
   1. As-Built drawings shall be submitted in AutoCad 2007 or later electronic format and duplicate hardcopy format when the system has been completely installed. Drawings shall indicate all wiring and connections.
   2. As-Builts shall include O&M manuals, cut sheets and manuals.
   3. Provide 3 copies electronically and in hardcopy

1.06 QUALITY ASSURANCE

A. Source Quality Control - Materials and equipment shall be new, unused and UL listed.

B. The system and components shall be supplied by one manufacturer of established reputation and experience who shall have produced similar apparatus far a period of five (5) years and who shall be able to refer to similar installations rendering satisfactory service.

C. The manufacturer’s authorized distributor and installation contractor for the specified systems, hereinafter known as the “CCTV System Trade”, shall install the CCTV Systems.

D. The installation shall include wiring, components, connections, adjustment, testing and certification. The Electrical Trade shall provide conduit, junction boxes and pull boxes as indicated, and required by the CCTV System manufacturer's drawings or Trade instructions. The CCTV Trade shall furnish any special boxes, cabinets, enclosures and similar items to the Electrical Trade for installation by the Electrical Trade in accordance with the manufacturer's drawings, Trade instructions, and as indicated on Drawings.

E. The CCTV System Trade shall furnish a list of similar or equal installations and demonstrate five (5) years certifiable experience in this type of work.

1.07 WARRANTY

A. The CCTV System manufacturer and Trade shall warrant the CCTV Systems for a minimum of two (2) years from date of acceptance by Owner against defective parts and/or workmanship and shall provide parts and labor to fulfill this warranty at no cost to Owner

B. Qualified service and parts shall be available to call on within a 150 mile basis

C. The CCTV System Trade shall include in his quotation the cost of three (3) inspections of the system during the two (2) year subsequent to the installation The Trade installing this equipment shall be prepared to offer the Owner a service contract after the guarantee period has ended On-the-premises service furnished at other than normal working hours shall also be available and shall be charged at current labor rates Sub-letting of this service shall disqualify the bidder.

1.08 COMMISSIONING

A. Final tests and inspection shall be held in the presence of the owner and to their satisfaction The CCTV System Trade shall supply personnel and required auxiliary equipment for this test without additional cost.

B. The completed CCTV Systems shall be tested to insure that it is operating properly. Acceptance of the systems shall also require a demonstration of the stability of the systems. This shall be adequately demonstrated if the system operates for a ninety (90) day test period without any problems. Should a problem occur, the System Trade shall readjust or replace the defective components and begin another ninety (90) day test period. This test shall not start until the Owner has obtained beneficial use of the building under tests.

C. If the requirements provided in the paragraph above are not completed within one (1) year after beginning the tests described therein, the CCTV System Trade shall replace either or both systems with another acceptable manufacturer and the process repeated until acceptance of the equipment by the Architect/Engineer.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. General
   1. All materials, equipment, accessories, devices and other facilities for the CCTV Systems shall be new, best suited for its intended use and shall conform to applicable and recognized standards for their use. All equipment shall be the standard cataloged products of the manufacturers shown.

B. The video surveillance system basis-of-design is General Electric (GE) Security (United Technologies Company, UTC Fire & Security), or equal manufacturer that is compatible with the existing GE Security software.

C. Application Software: GE-NAV v4, or higher.

D. Recording Equipment (Network Video Recorders): TruVision 32 channel Network Video Recorder (NVR) by GE Security/UTC Fire & Security.

E. Switching Equipment: General Electric: GE 24 port 1000+4 GigE SFP POE stackable managed switch (part number GE-DSSG-244-POE) with GE S30-2MLC fiber module.

F. Video Cameras:
   1. Interior Fixed Camera: UTC TVD 3103
   2. Interior 360° Camera: UTC TVF-3103
   3. Exterior Fixed Camera: UTC TVD 3104
   4. Exterior 360° Camera: UTC TVP 3104

G. Power Supplies: Altronix, or approved equal, with Yuasa rechargeable batteries.

H. Cabling:
   1. Acceptable manufacturers: Belden, Berk-Tek, Coleman, General Cable Technologies, Mohawk/CDT, and West Penn Wire/CDT.
   2. NFPA 70, Type CMP plenum rated per manufacturer's recommendations.

3. Unshielded twisted pair (UTP) camera cabling: Category 6, plenum rated.
4. Cabling is to be adequately sized for the installed distance to devices.

I. Accessories:
1. Bosch D166 telephone jack, Bosch D5215 memory expansion board.
2. Surge protection: DITEK Corporation, or approved equal.
3. Uninterruptible power supply (UPS) for recording equipment: APC, or approved equal.
4.

PART 3 EXECUTION

3.01 INSTALLATION

A. General
1. Provide the CCTV System with all wire, cables, conduit, outlets and equipment as on the drawings and as specified herein.
2. All material and/or equipment necessary for the complete and proper operation of the system, even though not specifically mentioned in the Contract Documents, shall be deemed part of this Contract.
3. All equipment shall be installed and connected in strict accordance with the manufacturer's recommended instructions so as to provide for matched systems for service maintenance from one source, all equipment shall be furnished by one equipment supplier except where indicated

B. Wiring
1. Complete Conduit Raceway System All wiring methods shall be in accordance with NFPA-70, Article 800, and all other codes specified herein Provide proper number, size of wires and conduit as required for operation of the system in accordance with the manufacturer's instructions. All wiring methods on the system's load side shall be shielded power limited type in conduit as specified in NEC Article 800
2. No wiring other than that directly associated with the system shall be permitted in these conduits.
3. Wiring splices are to be avoided to the extent possible, and if needed they must be made only in junction boxes and shall be crimp connected Wire nut-type connections are not acceptable on low voltage control
4. Transposing or changing color coding of wires shall not be permitted
5. All conductors shall be labeled on each end with "E-Z markers" or equivalent
6. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its termination
7. Cabinet terminals shall be numbered and coded All controls, function switches, etc, shall be clearly labeled on all equipment panels
8. All power connections to racks, cameras, devices and equipment shall be made with crimp-type terminal connections, or resin core solder method approved by manufacturer.
9. All coaxial cable (RG-59 and RG-6) connections shall be made with BNC connectors.
10. All wiring shall be checked and tested to insure that there are no grounds, opens or shorts.
11. Coaxial line shields are to be grounded only at the camera connector and at the video input module connectors. Shields on cables between accessory items of equipment are to be grounded at one end only. All cable shields are to be insulated at the "floating" end. Continuity of shield is to be preserved at all connecting points.

12. All audio grounds in any equipment rack, as well as the racks themselves, are to be earth grounded certain coaxial cables shall require cable "isolation transformers" to prevent ground looping.
13. All wiring shall be executed in strict adherence to standard practices Camera coaxial cables and 24 volts AC, and remote wiring to be installed in separate conduits All conduits shall be well spaced from power conduits, and shall be properly grounded to the building grounding electrode system ground Lines in conduit are not to be spliced.
14. All boxes, conduits, etc , shall be of proper size, as determined by the CCTV Systems Trade, shall be clearly marked for easy identification, and continuously grounded together.
15. All equipment except portable equipment shall be firmly held in place. Fastenings and supports shall be adequate to support their loads with a safety factor of at least three. All exterior hardware shall be proper stainless steel or hot-dipped galvanized unless aluminum is encountered.
16. The CCTV System Trade shall take such precautions as are necessary to prevent and guard against E M I, supply adequate ventilation, and to install the equipment so as to provide reasonable safety for the operator.
17. The actual circuit routing of the CCTV System shall be by the installing trade based on the location of the devices, circuit limitations and wire limitations.
18. All co-axial cable, control wiring and power wiring to exterior camera locations shall have surge or transient protectors as required by U L, NEC, EIA, TIA and the manufacturers.

C. Cabinet Equipment Location
1. The video monitors, multiplexers, multiplexer servers and DVR's shall be installed in the CCTV racks.
2. The camera power supplies shall be mounted in the top of the rack to avoid overheating and conflicts in the cabinet.

3.02 FIELD QUALITY CONTROL

A. General: Upon completion of the installation, the CCTV System Trade's factory-trained technician shall perform all necessary electrical tests and adjustments and who shall then submit a Letter of Certification to the Owner/Architect/Engineer that the system functions and conforms to all requirements of the manufacturer of the equipment, these specifications, and all requirements of the building code for the type of building in which the system is installed.

B. Inspection
1. The CCTV System Trade shall be responsible for all arrangements for testing and approval of the system before the system is accepted by the Owner and Architect/Engineer.

C. The factory-trained technician shall perform all electrical and mechanical tests, measurements and adjustments required below. All test costs shall be in the Contract price. A checkout report shall be prepared by the installation technicians and submitted in triplicate. The report shall include, but not be limited to:
1. A complete list of equipment installed and wired.
2. Indication that all equipment is properly installed and functions and conforms with these specifications.
3. Technician's name, certificate number and date.

D. After completion of all tests, measurements and adjustments listed above, the CCTV System Trade shall submit the following information to the Architect/Engineer:
1. "As-built" conduit layout diagrams including wire color code and/or tag number.
2. Complete "as-built" wiring diagrams.

3. Complete operating and programming instructions, including engineering data sheets on each major component and complete servicing data including part numbers of the various components.

3.03 DEMONSTRATION

A. Instruction: The installation supervising technician for the CCTV System Trade shall instruct the proper designated authority on the programming and correct operation of the system after the installation is completed. This shall include a two day in-house classroom type instruction period for all personnel, (24 hours) scheduled at the convenience of the security staff.

B. Programming: The CCTV System Trade shall provide initial programming to suit the Owner's initial operation and provide additional on-site technical support for five (5) eight (8) hours days in addition to the classroom instruction.

END OF SECTION

SECTION 28 31 00 - FIRE DETECTION AND ALARM

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 WORK INCLUDED

A. This Section of the specification covers the furnishing and installing of a new complete addressable voice fire alarm system for Robert Poole Building #056, as described herein and as shown on the drawings. The work covered by this section of the specifications includes the furnishing of all equipment, labor, materials, and performance of all operations, including field programming of the new system associated with the installation. Disconnecting and removal of the existing fire alarm system, devices, wiring, and exposed conduit is also included.

B. Provide Fire Alarm Control Panel (FAP), fire alarm voice panel (FAVP), remote Fire Alarm Annunciators (FAA), alarm initiating devices, alarm indicating appliances, and all required connections as shown on the drawings. The FAP shall be UL listed for use as per Control Units (UOJZ). The detection system shall provide smoke and heat detectors, manual pull stations and duct detectors in areas indicated on the drawing. Provide audible/visible notification throughout.

C. Provide necessary equipment, miscellaneous connections, and programming required to interface the new system with the Supervising Station selected by the Owner and as allowed by the Fire Marshal.

D. Provide all interface modules necessary to interconnect the building FAP with the HVAC fan and damper controls, kitchen hood fans and associated suppression systems, electromagnetic door holders, and other required initiating or control output devices as applicable. Coordinate all locations of required interconnections in the field.

E. The system shall include all wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, alarm and supervisory signal initiating devices, alarm notification appliances, and all other manufacturer proprietary equipment such as Signaling Line Circuit (SLC) modules, notification appliance circuit modules, and other accessories and miscellaneous items required for a complete operating system in the building.

F. The layout on the drawings is diagrammatic. A single fire alarm control panel and Remote Fire Alarm Annunciators are indicated. Provide Notification Appliance Circuit (NAC) extender panels (auxiliary power supplies) and amplifier panels as required in approved locations. Where additional remote fire alarm control units, NAC extender panels, or similar fire alarm related equipment are needed, they shall be provided at a suitable terminal cabinet location. Each remote fire alarm control unit shall be powered from a wiring riser specifically for that use or from a local power panel. All fire alarm power circuits shall be dedicated. Where remote fire control units are provided, equipment for notification appliances may be located in the remote fire alarm control units.

G. In lieu of a fire alarm graphic annunciator, the fire marshal has agreed to placing framed floor plans near the point of entry to the building. The Professional will provide 8 ½ x 11 to 11x 17 floor plans with the appropriate information to the contractor. The contractor shall in turn print these in color, frame, and mount in the location acceptable to the fire marshal. Frames cannot be simply hung. The frames shall be mounted with anchors that firmly affix the frame to the wall, but allow the graphic to be updated in the future.

H. Provide a Knox drawing / document box adjacent to the fire alarm panel. Provide a full size set of as-built drawings, half size set of as-built drawings, and a flash drive containing PDF files of he as-built drawings in the document box. Key the box to match the fire alarm panel key.

I. Related Sections include the following:

1. Division 01 Section “Construction Waste Management”

2. Division 01 Section "LEED Requirements" for additional LEED requirements.

1.3 DEFINITIONS

A. Wherever mentioned in this specification or on the drawings, the nomenclature, equipment, devices, appliances, and functions shall be as defined by NFPA 72 or as follows:

1. Authority Having Jurisdiction (AHJ) – For the purpose of these documents the term AHJ is defined as are other commonly used terms for personnel associated with review or approval as follows:
   a. AHJ – Baltimore City and Maryland Stadium Authority
   b. Fire Marshal – Baltimore City Fire Department – Fire / Code Enforcement
   c. Owner – Baltimore City Public Schools
   d. Professional – Brinjac Engineering, Inc.
   e. Construction Manager (CM) – Baltimore City Public Schools Facilities Design and Construction
   f. Insurance Carrier – Agent for the Owner that provides insurance coverage for the project.

2. Terminal Cabinet – A steel cabinet with locking, hinge-mounted door in which terminal strips are securely mounted. Minimum size is 8-inches by 8-inches.

3. Furnish – To supply the stated equipment or materials.

4. Install – To set in position and connect or adjust for use.

5. Provide – To furnish and install the stated equipment or materials.

6. Contractor – Shall refer to the Fire Alarm/Electrical Contractor.

1.4 APPROVALS

A. The Contractor must comply with all laws, ordinances, and regulations of all Authorities Having Jurisdiction (AHJ), including Borough, County, State, Federal, Public Utility, and the Owner's insurance carrier.

B. Battery calculations, product data sheets, shop drawings and all other associated submittals must bear the stamps of and be reviewed and/or approved by the AHJ and the Owner's insurance carrier. Any and all comments received from the aforementioned reviews, and resolution thereof, shall be submitted to the Professional for record.

C. The Contractor shall submit full and complete shop drawings to the Professional for review and obtain a stamp of approval from the Professional prior to installation.

1.5 FIRE ALARM DESIGN

A. System shall be a complete, supervised, non-coded, addressable fire alarm system conforming to NFPA 72. The system shall operate in accordance with the Matrix of Operations shown on the Contract Drawings. The system shall remain in the alarm mode until all initiating devices are reset and the FAP is manually reset and restored to normal status. The system shall provide the following functions and operating features:

1. All fire alarm system circuits shall be electrically supervised. Provide Class B Signaling Line Circuits (SLC) and Class B Notification Appliance Circuits (NAC). Provide supervision of the primary power supply, presence of the battery, battery voltage, and placement of the modules within the panel.

2. Automatic response functions shall be accomplished by the first device initiated. Alarm functions resulting from initiation by the first devices shall not be altered by subsequent alarms.

3. Alarm, supervisory and trouble signals shall be automatically transmitted to the approved Supervisory Service via dedicated telephone lines. Provide two (2) telephone lines from the main telephone service board to the automatic reporting device and make all necessary connections for a complete operating system including a 120V, 20 amp circuit and/or phone jacks if required. The Owner shall be responsible for any required telephone company line installation and connection fees.

4. History log function shall be enabled and shall include all alarms, trouble signals, and reset activities/events. The history log shall not be erased during complete loss of power.

5. The Environmental Compensation function shall be enabled.

6. Adjustable sensitivity for detectors.

7. Block Alarm and Acknowledge shall be provided.

8. The trouble signals shall be non-latching.

9. Alarm Verification shall be available.

10. Device Confirmation shall be enabled.

11. All function keys shall be programmed in accordance with the AHJ and Owner's specific requirements.

12. Provide program capability via switches in a locked portion of the FAP to bypass the automatic notification appliance circuits, kitchen shunt mechanisms, air handler shutdown, supervising station and other output features. Operation of this programming shall indicate a trouble condition on the FAP and printer output.

13. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.

14. The system shall be capable of being programmed in the field. All programmed information shall be stored in non-volatile memory.

15. The system shall be capable of operating, supervising, and/or monitoring both addressable and non-addressable alarm and supervisory devices.

16. There shall be no limit, other than maximum system capacity, as to the number of addressable devices which may be in alarm simultaneously.

17. The system shall be configured to permit a single person walk-test to be performed.

B. Detection Initiation

1. Alarm Verification – Feature shall be field programmable for all smoke detectors in accordance with IBC. Cross-zoning shall not be permitted as a substitute for alarm verification.

2. Detector Sensitivity Check/Adjustment – Individual smoke detector sensitivity checking and adjusting for alarm condition shall be provided at the FAP. Said sensitivity checking and adjusting shall meet and be listed by UL for this function.

3. Detector Maintenance Monitoring – Provide monitoring of smoke detector chambers for gradual buildup of foreign materials in the sensing chamber. When the smoke detector senses a high level of contamination, the control panel shall cause a trouble condition and indicate the specific detector location in need of maintenance.

4. Automatic Drift Compensation – All smoke detectors shall be monitored for changes in sensitivity ranges and automatically adjust the detection range up or down to compensate for environmental changes or degradation of detector components.

1.6 OVERVOLTAGE AND SURGE PROTECTION

A. Signaling Line Circuit Surge Protection. All communications equipment shall be protected against surges induced on any SLC. All cables and conductors, which serve as communications links, shall have surge protection circuits installed in accordance with the Manufacturer's recommendations.

B. Power Supply Circuit Protection. The 120 VAC power supply for the FAP shall be protected against surges in accordance with the Manufacturer's recommendations.

C. Fuses shall not be used for surge protection.

D. Wiring extending outside the building, either underground or overhead, shall meet the requirements of the NEC, NFPA 72, and the manufacturer with respect to lightning and other induced surges. Provide low voltage line protection at the wire entry point to each building (e.g. the main building and the modular classrooms).

1.7 QUALITY ASSURANCE

A. Contractor:

1. "Contractor" is defined as the company and authorized representative thereto that installs the fire alarm equipment.

2. Installation shall be accomplished by a Contractor with a minimum of five (5) years experience in the installation of fire alarm systems. Contractor shall show evidence of certification of at least 1 employee directly responsible for the work by the National Institute for Certification in Engineering Technologies (NICET) at Level II, III, or IV in the Fire Alarm Systems subfield of Fire Protection Engineering Technology; or, a Registered Engineer with similar experience in Fire Alarm System installation.

3. If such a certified individual is not employed, adequate documentation shall be provided to show comparable training and experience of an existing employee. At a minimum, comparable training and experience shall consist of 5 years of progressive experience in the installation and design of fire alarm systems of similar size and complexity to that specified herein. Any proposed installer who cannot show evidence of such qualifications may be rejected. The services of a technician certified by the control equipment manufacturer shall be provided to supervise installation adjustments and tests of the system.

B. Distributor:

1. "Distributor" is defined as the company and authorized representative of the Manufacturer that distributes and designs the fire alarm system and associated equipment provided by the Manufacturer and installed by the Contractor.

2. The Distributor shall show evidence of certification by the Manufacturer in the technical support of the system installed under this contract. Documentation of factory Manufacturer training on the system and products being provided is required for an individual directly associated with the project.

3. The Distributor shall show evidence of certification of at least 1 employee by the National Institute for Certification in Engineering Technologies (NICET) at Level III or IV in the Fire Alarm Systems subfield of Fire Protection Engineering Technology; or, a Registered Engineer with similar experience in Fire Alarm System design and installation.

4. If such a certified individual is not employed, adequate documentation shall be provided to show comparable training and experience of an existing employee. At a minimum, comparable training and experience shall consist of 5 years of progressive experience in the installation and design of fire alarm systems of similar size and complexity to that specified herein and demonstrate experience with the design and installation of the system being provided. Additionally, provide documentation for the registered PE or NICET level person that will review and certify the design.

C. Manufacturer and Equipment:

1. "Manufacturer" is defined as the company and authorized representative thereto that produces the fire alarm equipment.

2. Each item of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the UL label. All control equipment is to be listed under UL category UOJZ as a single control unit. Partial listing shall NOT be acceptable.

3. All devices shall be listed for use with the UOJZ listed control panel. Any associated third party equipment that is not required to be specifically listed for use with the control panel, shall be certified as being acceptable for use with the specified system by the Manufacturer.

4. Testing Services or Laboratories:
   a. Provide fire alarm and detection system components that are UL listed and FM approved and labeled for their intended use and service. Construct all fire alarm and fire detection equipment in accordance with the latest edition of publications from Underwriters Laboratories (UL) and Factory Mutual Engineering Corporation (FM) such as:
      1) UL 228 – Door Holding Devices
      2) UL 464 – Audible Signal Appliances
      3) UL 864 – Control Units for Fire Protective Signaling Systems
      4) UL 1480 – Speakers for Fire Alarm, Emergency, and Commercial and Professional Use
      5) UL 1971 – Signaling Devices for the Hearing Impaired

D. Codes and Standards:

1. Maryland Building Performance Standards
   a. 2015 IBC with Department of Housing and Community Development (DHCD) modifications (Ref: COMAR 05.02.07)
   b. The State of Maryland Fire Prevention Code incorporating NFPA 1 Fire Code 2012 and NFPA 101, Life Safety Code 2012 (COMAR 29.06.01) including State Fire Marshal modifications

2. Any local Baltimore City Codes, Amendments or Ordinances.

3. National Fire Protection Association (NFPA) (IBC referenced edition if so designated, otherwise latest edition):
   a. NFPA 70, National Electrical Code (NEC) – 2011 edition
   b. NFPA 72, National Fire Alarm Code

4. Americans with Disabilities Act (ADA) and the Americans with Disabilities Act Accessibility Guidelines (ADAAG).

5. Underwriters Laboratories (UL), Current Edition or Verified Supplements.
   a. Fire Protection Equipment Directory
   b. Electrical Construction Materials Directory

6. Factory Mutual (FM) Approval Guide, Current Edition or Verified Supplements.

7. The Owner's Insurance Carrier.

1.8 SUBMITTALS

A. Refer to any front end general project or electrical specifications for basic information relating to submittal requirements.

B. The Fire Alarm/Electrical Contractor is responsible for all fees and efforts associated with the required approvals.

C. Prior to installation of any materials and/or system components, all fire alarm system shop drawings and equipment must be approved by and bear the stamp of the AHJ and the Owner's Insurance Carrier as applicable. Provide construction documents as specified in IBC 907.1.1 to the AHJ. Any and all comments received from these reviews shall be submitted to the Professional. After approval by the aforementioned agencies and review by the Design Professional, submit 1 complete record set of documents bearing the aforementioned agencies approval to the Owner and another to the Professional.

D. Submit all shop drawings to the Design Professional for review and approval. Submittals are to be complete. Partial submittals shall not be accepted except as follows. Include in the first submittal a schedule indicating the packaging and estimated delivery date of all required submittals. Example: Submittal 1 (date) will include: Contractor Qualifications, Phasing Plan, and Catalog Data. Submittal 2 (date) will include: AHJ approvals and Drawings and Calculations. Submittal 3 (date) will include: System Messages, Test Plan and Extended Service Agreement.

E. The submittal shall be made as a complete package consisting of fire alarm equipment ONLY. The submittal shall NOT include other electrical equipment or components not directly related to the fire alarm system installation (e.g., security, sound systems, power, etc.) for approval. Where other equipment or components are an integral part of the fire alarm system, they shall be indicated as such but not included with the submittal and only show required interface details. Failure to submit all required materials as a complete, separate, single package shall be cause for rejection of entire package. Copies of the Contract Documents with contractor's notes thereon will be rejected. Simply redlining the Contract Documents is not acceptable. For any resubmittals to the Professional, provide a written response to any previous comments.

F. The fire alarm equipment distributor shall submit documents as specified in the Qualifications portion of this Section. The submittal shall include identification of the following:

1. Name, title, address, and proof of qualifications for each "Contractor" and authorized representative, "Distributor" and authorized representative, and "Manufacturer" and authorized representative.

2. When the distributor intends to utilize the services of a manufactured-affiliated company in the system design, the distributor shall submit a letter of intent to do so, addressed to the Professional, which includes the name of the manufacturer-affiliated company, the names and qualifications of the NICET-certified or registered Engineer employees of the company, and which describes the delegation of fire alarm system design responsibilities.

G. Provide a narrative description of the phasing plan.

1. Outline the sequence of demolition, installation, and acceptance testing.

2. Describe how the systems will be configured to work as a single combined system during the transition.

3. Provide updates to the Professional on a monthly basis including projected dates.

H. System Component Data, Shop Drawings, and Calculations:

1. Drawings shall be to scale. Submit 24x36 or 30x42 inch shop drawings at a scale not smaller than 1/8 inch = 1 foot. All drawings to be in CAD. System component data and calculations shall not be smaller than letter size.

2. Symbols shall be consistent for the entire shop drawing package. Therefore, the symbols used on the floor plan drawings shall be the same symbols used on the riser diagram and details. Submitting a riser diagram with a copy of the Contract Drawings used as the floor plans is unacceptable and will result in rejection of the shop drawings.

3. As a minimum, the fire alarm and fire detection shop drawing submittal shall include the following:
   a. Include annotated catalog data showing manufacturer's name, model, voltage, and catalog numbers for all equipment and components. Where multiple configurations of equipment or options are available, indicate specific configuration being submitted.

b. Provide floor plans showing the location of all control units, power extenders, devices, equipment, and appliances and their addresses; including identification of equipment controlled or monitored by the fire alarm system (e.g., fans, dampers, etc.). Show circuiting between all devices. Show locations for all junction boxes used for T-taps. Indicate conduit fill percentages on the plans.

c. Provide complete riser diagrams indicating the wiring sequence of all devices, equipment, and appliances, their addresses, and their connections to the control equipment. Provide a color code schedule for the wiring.

d. Provide point-to-point wiring diagrams showing the points of connection and terminals used for all electrical field connections in the system, including all interconnections within fire alarm cabinets, and between the equipment or systems which are supervised or controlled by the fire alarm system. Diagrams shall show all connections from field devices (interface modules, all fire protection equipment, detectors, manual pull stations, notification appliances, etc.) to the FAP and remote FAA, initiating circuits, switches, relays and terminals, and other ancillary equipment.

e. Provide wiring diagrams and drawings to depict the layout of the power supplies and corresponding audible/visible circuits. Provide circuit numbers for each NAC and SLC circuit.

f. Provide drawings and a description of how the fire alarm system meets the requirements to synchronize all the notification appliances throughout the building.

g. Provide data on each circuit to indicate that there is at least 20 percent spare capacity for notification appliances on the NAC, 20 percent spare capacity on the amplifier circuits, and 20 percent spare capacity for initiating devices on the SLC (e.g., not more than 80 percent loaded). This portion of the submittal shall include wire sizing calculations to show that the wiring lengths and wire gauge provide adequate voltage to the last device on a circuit. Example - An 8 amp power supply would not be loaded to more than 6.4 amps and if the audible/visible appliance is rated for 20 to 24 volts DC, the wire sizing calculations would show that the last device has a minimum voltage of 20.8 volts. The calculation shall be provided in a tabular format. Simply providing the amperage at the end of the circuit on the riser or plan drawings is not acceptable.

h. Provide complete battery calculations for both the alarm and supervisory power requirements. The calculation shall include: identification, quantity, and ampere-hour requirements for each system component and/or device in both the standby and alarm conditions in a tabular or other easily discernible format. In addition to any manufacturer's recommended derating factor, provide an overall minimum 20 percent Safety Factor.

i. Provide a complete description of the system operation. This shall be a written summary or detailed expansion of the Matrix of Operations shown on the contract drawings.

j. Provide mounting details for all panels. Provide typical mounting details for each type of device for each unique mounting application (e.g., ACT or gypsum ceiling, steel beams or trusses, block or gypsum walls).

k. Include submittal data for all wire, terminal cabinets, and raceways. Provide color samples as required.

l. Provide a complete list of device addresses and their corresponding message to be displayed on the FAP and remote FAA. The wording of the system messages as they appear at the FAP and remote FAA panels shall be submitted for approval to the Owner and the Professional.

I. Provide a complete test plan for system testing at least three weeks prior to the Final acceptance test.

J. Submit a copy of the extended service agreement.

K. Upon receipt of final-approved shop drawing review, the contractor shall issue one set to the local Code Official.

L. LEED Submittal:

1. Product Data for Credit MR 4.1: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit MR 5.1:For products regionally manufactured materials
   a. Identify each regionally manufactured material, including its source and cost.
   b. Identify each regionally extracted and manufactured material, including its source and cost.

1.9 PROJECT RECORD DOCUMENTS

A. Prepare and submit 5 sets of detailed CAD "As-Built" drawings. The drawings shall show the system as installed, including all deviations from both the project drawings and the approved shop drawings. The drawings shall be prepared on uniform sized sheets the same size as the project drawings.

B. The drawings shall include complete plan view wiring diagrams showing connections between all devices and equipment, including, but not limited to, fire alarm panels, field devices and single line circuit routings between devices. Indicate conduit fill percentages on the plans. All equipment in panels shall be shown in the as-built orientation.

C. Provide drawings detailing all wiring connections within the FAP.

D. Include a riser diagram and drawings showing the as-built location and address or circuit number of all devices and equipment.

E. These drawings shall be submitted with the specified operations and maintenance manuals.

F. The drawings shall be placed in a Knox 1300 Series Cabinet or approved equal. The cabinet shall be installed next to the sprinkler head cabinet. The box shall be keyed to the same key as the building fire alarm system.

G. Upon completion of the project and after approval by the design Professional, submit one (1) complete, reproducible record set to the Owner. A single CAD (electronic) copy of the "As-Built" drawings shall also be provided.

H. All drawings submitted shall be signed and sealed by the Registered Engineer or the NICET employee of the distributor.

1.10 OPERATION AND MAINTENANCE DATA

A. Provide 5 bound copies of an operation and maintenance manual. Maintenance manuals shall be furnished complete and consist of fire alarm equipment and data only. Each shall contain sufficient detailed information to enable Owner's technicians to understand, operate and maintain the system equipment and to identify replaceable parts. The manual shall include:

1. An index.

2. Copies of ALL APPROVED SHOP DRAWINGS AND SUBMITTAL MATERIALS UPDATED TO "AS-BUILT".

3. A complete parts list of all components.

4. A copy of the completed and signed Testing and Inspection Form (from NFPA 72 or equivalent).

5. Operating instructions, maintenance and repair procedures, and troubleshooting guidelines.

6. Testing procedures and maintenance frequencies.

7. A list of recommended spare parts. The spare parts list shall include, for each item, the manufacturer's name, serial number of the part, an ordering number, if appropriate, and a physical and electrical description of the part.

8. A printout of the new system program, including all input and output addresses and messages displayed at the FAP and FAA. Failure to include the system program will be cause for withholding final payment.

9. A written copy of all passwords or other access codes for the FAP.

1.11 SERVICE AGREEMENT

A. Included in the bid price shall be a 1 year service contract, effective upon final system acceptance, to provide all service required beyond the warranty and the capability of the facility personnel. Contract shall include all service and repairs required under the warranty as well as quarterly, semi-annual, and annual system testing and inspection in accordance with NFPA 72.

B. The distributor shall make available to the Owner a testing and maintenance contract proposal to maintain the system in accordance with NFPA 72 for years 2 through 5. Breakout pricing on a per year basis. Owner is under no obligation to accept.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Edwards Systems Technology

B. Gamewell / Honeywell

C. Notifier

D. Silent Knight

E. Approved Equal

2.2 FIRE ALARM CONTROL PANEL (FAP)

A. Provide a complete control panel fully enclosed in a lockable steel enclosure as specified herein. All operations required for testing or for normal care and maintenance of the systems shall be performed from the front of the enclosure. If more than a single unit is required at a public accessible location to form a complete control panel, the unit enclosures shall match exactly.

B. Each control unit shall provide power, supervision, control and logic for the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit shall be suitable for operation on a 120 volt, 60 hertz, building power supply. The system devices shall operate at 24 volts DC. Provide each panel with supervisory functions for power failure, internal component placement, and operation. Visual indication of alarm, supervisory or trouble initiation on the fire alarm control panel shall be by liquid crystal display or similar means with a minimum of 80 characters of which at least 32 are field changeable.

C. The FAP shall be listed for Remote Station Service. Provide audible signals to indicate any alarm or trouble condition. The alarm signals shall be different from the trouble signal. Connect all circuit conductors entering or leaving the panel to screw-type terminals with each terminal marked for identification. Locate diodes and relays, if any, on screw terminals in the FAP. Circuits operating at 24 VDC shall not operate at less than 20.8 volts. Circuits operating at any other voltage shall not have a voltage drop exceeding 10 percent of nominal voltage.

D. Operation of the system shall be in accordance with the description under “SYSTEM OPERATION” of this specification section and as indicated in the Matrix of Operations shown on the Contract Drawings.

E. The cabinet enclosure shall be identified by permanent markings on the cabinet or by an engraved laminated phenolic resin nameplate. Lettering on the nameplate shall identify the cabinet and shall not be less than 1-inch high. Provide prominent rigid plastic or metal identification plates for all lamps, circuits, meters, fuses and switches. The cabinet shall be provided in a sturdy steel housing, complete with backbox, hinged steel door with cylinder lock, and surface mounting provisions.

F. Provide trouble and supervisory silencing switch that will silence the audible trouble and supervisory signal, but not extinguish the visual indicator. These switches shall be overridden upon activation of a subsequent alarm.

G. Provide a drill test switch which will activate the alarm indicating devices, but will not put the panel into the alarm mode and will not notify the Supervising Station.

H. Power and supervise each circuit such that a signal from a single device does not prevent the receipt of signals from any other device. All circuits shall be manually resettable by switch from the FAP after the initiating device or devices have been restored to normal.

I. The fire alarm system shall activate general building alarm utilizing the "Temporal Tone", followed by a voice message.

J. Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors or other age-dependent devices shall not be considered as equal to non-volatile processors, PROMS or EPROMS.

K. Provide control units and control panels that are fully field programmable for control, initiating, supervisory and trouble functions of both input and output. The system program configuration shall be menu-driven. All system changes shall be password protected and shall be accomplished using personal computer based equipment. All system changes shall be in non-volatile memory.

L. The FAP shall contain features which allow the bypassing of input devices from the system or the modification of system outputs. These control features shall be accessible from a panel mounted keypad. Any bypass or modification to the system shall indicate a trouble condition on the FAP and a printed output of the trouble condition.

M. Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory or trouble condition on the system still exists.

N. Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the FAP. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory and trouble. The instructions shall be approved by the Owner and the Professional before being posted.

O. The FAP shall have a walk test feature. When using this feature, operation of initiating devices shall result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated on the system printer, but no other outputs occur.

P. Secondary source for emergency power to the FAP:

1. Provide a battery powered secondary power system with sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24 hours. Following this period of normal operation, the batteries shall have sufficient capacity to operate the system during a fire or other emergency condition for a period of 15 minutes for voice alarm.

2. The battery secondary power source shall be sealed lead-acid or nickel cadmium batteries. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

3. Provide a solid state, fully automatic, variable charging rate battery charger. The charger shall be capable of providing 150 percent of the connected system load and shall maintain the batteries at full charge. In the event the batteries are fully discharged, the charger shall recharge them back to full charge in twelve hours.

Q. The loss of primary power at the FAP shall result in a trouble signal at both the FAP and the FAA.

2.3 SYSTEM PRINTER

A. Stand Alone Printer Capability: Provide capability and components within the fire alarm panel to connect a stand-alone printer for service and maintenance needs. The printer shall be capable of being utilized for maintenance or system troubleshooting as well as recording alarms.

2.4 COMMUNICATOR

A. Provide a communicator compatible with the Owner's supervising station to transmit signals as specified in the Matrix of Operations.

B. A 3/4 inch conduit with the required conductors shall be extended from the digital communicator to the nearest telephone terminal board. The telephone company or contractor shall provide and install an interface terminal block. Electrical Contractor shall terminate conductors on 1 side of this terminal block as directed by the telephone company or contractor. This contractor shall provide telephone jacks as required. The Owner shall contract with the telephone company for 2 dedicated phone lines for the digital communicator.

2.5 TONE GENERATORS

A. General: Tone generators and all other hardware necessary for a complete, operational alarm signaling service conforming to NFPA 72 shall be housed within a panel having the same construction features as that of the FAP.

B. Tone Generator: The tone generator shall be of the modular, plug-in type with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces. The tone generator shall produce a three-pulse temporal pattern fire alarm evacuation signal and be constantly repeated until interrupted by the alarm silence mode as specified. The tone generator shall be single channel with an automatic backup generator per channel such that failure of the primary generator causes the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay.

2.6 AUDIO VOICE PANELS

A. The FAP shall have an associated Voice Alarm or Audio panel that is UL listed for use with the FAP.

1. The Voice Panel shall have a minimum of 3 channels for simultaneous paging and signaling, a paging microphone and be capable of either utilizing 25 or 70.7 Vrms speakers.

2. A full set of switches shall be provided with the panel for functions such as ALL CALL and the ability to selectively call individual areas. Systems that cause signaling devices to go silent while performing signaling functions shall not be acceptable.

3. A microphone mounted in the master control or remote control unit shall allow for the announcement of a message in the building. Any number or all speaker circuits can be selected to receive these voice messages. The master module shall include local speaker and volume control to monitor audio signals. An optional pre-page tone shall be programmable for microphone use.

B. Amplifiers

1. Amplifiers may be distributed throughout the building or centrally banked.

2. A minimum of one common backup amplifier shall be provided for the largest size amplifier used at a location. The transfer to the backup amplifier shall be automatic upon the failure of any one of the primary amplifiers. This transfer to the backup amplifier shall be indicated as a trouble condition on the master control unit.

3. Amplifiers shall have integral power supplies for operating traditional notification appliance circuits.

C. Messaging capability: The panel shall be capable of providing multiple voice messages depending on the event. Custom messages shall be utilized. The capacity of the panel shall provide for the ability to annunciate distinct messages specifying the location of the alarm as well as unique instructions per event per area.

2.7 AUXILIARY POWER SUPPLIES

A. Auxiliary power supplies or notification extender panels of the same Manufacturer as the FAP, or listed for use with the FAP, shall be installed as necessary to provide power to the visible alarms and other required equipment.

2.8 REMOTE FIRE ALARM ANNUNCIATOR (FAA)

A. The Remote FAA panels shall provide the same alpha-numeric display as that of the FAP. FAA panels that provide minimal control functions such as the ability to acknowledge, silence, and reset are acceptable in lieu of those providing full control functions. Size of the panel is a consideration with smaller panels being preferred.

2.9 MONITOR AND CONTROL MODULES

A. Provide supervised addressable monitor and control modules as appropriate to interface with required devices. These devices may also require control relays depending upon the device being interfaced. This includes, but is not limited to, HVAC systems, electromagnetic door holders.

B. Modules shall be of the type that mount in a 4 inch square box. The use of addressable relays and mini-modules is acceptable for certain applications with the prior approval of the Professional. Any such use of addressable relays and mini-modules shall be identified in the submittals along with mounting or securing details for each application.

2.10 MANUAL PULL STATIONS

A. Provide addressable single-action type manual pull stations throughout. The stations shall have an impact resistant polycarbonate or cast or extruded metal cover, finished in red with molded raised letter operating instructions of contrasting color. Stations requiring the breaking of a glass panel are not acceptable.

B. Provide single action type manual pull stations with a clear plastic cover to protect the device from damage on all pull stations throughout the building. The cover shall produce an audible alarm when lifted. Provide the STI Stopper II Model STI-1130 or equivalent.

C. Furnish stations which require the use of a key or a wrench to reset. All stations shall be master keyed with the fire alarm control panel. Station switches and contacts shall be rated for the voltage and current at which they shall operate. Stations shall be supplied with screw terminals for making connections.

D. Where devices are located in an area subject to high humidity or adverse conditions (e.g., exterior, showers, etc.) indoor/outdoor, weatherproof appliances shall be provided.

E. Provide red surface mounted back boxes provided by the manufacturer of the manual pull station.

2.11 SMOKE DETECTORS

A. Provide addressable multi-criteria open area and duct smoke detectors as follows:

1. Provide smoke detectors utilizing multi-criteria features for operation. Smoke detectors shall be listed for use with the fire alarm control panel.

2. Provide self restoring type detectors which do not require any readjustment after actuation to restore it to normal operation. Detectors shall be UL listed as Smoke – Automatic Fire Detectors. Install detectors in accordance with the requirements described in the listing.

3. Detectors shall have alarm verification capability and an environmental compensation feature and provided with an insect screen.

4. Provide twist lock bases for the detectors. The detectors shall maintain contact with their bases without the use of springs. Provide companion mounting base with fixed wiring terminals. The detector shall have a visual indicator to show actuation.

5. The detector address shall identify the particular unit, its location within the system, and its sensitivity setting. Detector shall be of the low voltage type rated for use on a 24 VDC system.

6. Detectors shall be equipped with screw terminals for each conductor.

7. Duct smoke detectors shall be furnished and installed by the Fire Alarm Contractor. The Fire Alarm Contractor shall coordinate sampling tube sizes. All duct smoke detectors located 10-feet or higher, located above finished ceilings, or otherwise hidden from view, shall be furnished with remote alarm indicator lamps and test stations located in a readily accessible location, along with identification nameplates clearly indicating the device and its location.

2.12 HEAT DETECTORS

A. All heat detectors shall be of the type that mount to twist lock bases (similar to the smoke detectors), unless the product line does not support the device specified. In that case, provide an addressable detector from the manufacturer's standard product line or a non-addressable device with the appropriate interface module. These detectors shall be equipped with screw terminals for each conductor. All detectors or twist bases shall be designed for outlet box mounting and supported independently or wiring connections.

B. Heat detectors shall be fixed temperature type where specified on the drawings. The fixed temperature shall occur at 135 or 195 degrees Fahrenheit (nominal) and be provided at temperature ratings as required for maximum or ambient normal heat levels.

C. Heat detectors shall be combination rate-of-rise and fixed temperature type where specified on the drawings. Rate-of-rise operation shall be set a nominal 15 degrees Fahrenheit per minute; fixed temperature shall occur at 135 degrees Fahrenheit (nominal) or as otherwise required for maximum or ambient normal heat levels.

D. Provide multi-criteria smoke, heat, and carbon monoxide detectors in the Boiler Rooms, Mechanical Rooms, and Kitchen. If a single device is not available, the Contractor shall provide a fixed temperature heat detector, carbon monoxide detector, and monitor module to monitor the carbon monoxide detector.

2.13 NOTIFICATION APPLIANCES

A. Provide notification appliances in areas as indicated on the Contract Drawings. Combination audible/visible appliances in a single wall or ceiling mounted unit shall be used in all locations where a combination unit can be provided. Separate audible or visible appliances may be used as necessary for coverage of odd shaped areas to form a complete and functional system.

B. Wall Mounted Devices shall be flush mounted throughout the building. Surface mounted devices are permitted in mechanical rooms and like areas. All wall mounted devices shall be white unless otherwise noted.

C. Ceiling Mounted Audible, Visible, and Combination Audible/Visible shall be white unless otherwise noted.

D. Audible/visible devices in areas subject to damage, such as gymnasiums, shall be provided with a wire metal protective cover to protect the device from damage. Plastic covers that reduce light and sound transmission are not acceptable.

E. Audible Appliances:

1. All audible appliances shall be capable of installation on standard 4-inch (100 mm) square electrical boxes. Provide fire alarm horns conforming to UL 464, having separate terminations for each “in” and “out” connection.

2. Audible appliances shall provide a minimum output sound of 15 dBA above ambient throughout the building in accordance with NFPA 72. The appliance shall have a minimum rating of 90 dBA at 10-feet (3 m) as determined by the reverberant room test; data on peak output as determined in an anechoic chamber is not suitable. Audible appliances throughout shall emit a synchronized, temporal signal followed by a voice message.

3. Provide notification appliance mounting plates constructed of cold rolled steel having a minimum thickness of 16 gauge and equipped with mounting holes and other openings as needed for a complete installation. All fabrication marks and holes shall be ground and finished to provide a smooth and neat appearance for each plate. Each plate shall be primed and painted red. Provide terminal blocks for making connections.

4. Speakers shall be of high-efficiency design and life safety rated for both electronic tone signaling and voice applications. Each speaker shall have multiple watt taps to allow for field adjustment.

5. Provide amplifiers as required.

F. Visible Appliances:

1. Visible alarm indicating appliances shall be xenon strobe lights meeting the requirements of UL 1971. Strobes shall have a flash rate of between 1 and 3 HZ. Visible appliances throughout each floor shall be synchronized.

2. The strobe lens shall conform to the Americans with Disabilities Act. Strobes shall be designed and listed as required for wall or ceiling mounting as applicable.

3. The Strobe lens housing shall be white and engraved or stenciled with the word “FIRE”.

4. Ceiling mounted devices shall be specifically approved for ceiling mounting. Wall mounted devices shall not be used for ceiling applications unless approved for such use.

2.14 TWO-WAY EMERGENCY COMMUNICATION SYSTEM

A. A two (2)-way emergency communication system which complies with the Americans with Disabilities Act Accessibility Guidelines (ADAAG) and IBC requirements shall be provided for the building. The system shall provide two-way communication between the system control panel and the call boxes located at each elevator lobby and as otherwise shown in the drawings. The two way communication system shall also have controlled access to a public telephone system.

B. The communication system shall provide both audible and visual communication between the elevator lobbies and the system control panel.

C. The audible communication shall consist of a dedicated telephone system with handsets located at each elevator lobby or a dedicated intercom system installed in accordance with the requirements of NFPA 72 which connects each elevator lobby with the system control panel.

D. Visual communication shall consist of a call button with an indicator light in each area of refuge and a system control panel located adjacent to the FAA in the main building lobby. A call button with an associated indicator light for elevator lobby shall be provided. Activation of the call button in any area of refuge will illuminate the corresponding indicator light on the system control panel identifying the location of the activated call button. Activation of any area of refuge call button on the system control panel will illuminate the indicator light located in the corresponding elevator lobby.

E. Provide 120 Volt power for the system from the building electrical systm. Provide a supplemental or auxiliary power supply as required.

F. Instructions shall be permanently secured adjacent to the communications system equipment in each area of rescue assistance. The instructions shall be provided in both text and Braille. The instructions shall include the following:

1. Instruction on the use and operation of the emergency two-way communication system.

2. Directions to find other means of egress.

3. Inform persons who are capable of using the exit stairs that they should do so as soon as possible unless they are providing assistance to others.

4. Instructions on how to summon assistance and direction in the use of stairs or the supervised use of the elevators.

G. Each door providing access to an elevator lobby from an adjacent floor area shall be identified by a sign complying with ICC A117.1, including the International Symbol of Accessibility. Where exit sign illumination is required by Section 1011.2, the area of refuge sign shall be illuminated. Additionally, tactile signage complying with ICC A117.1 shall be located at each door to an area of refuge.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT (LEED)

A. The contractor, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the contractor's "Waste Management Plan" as required by Division 01 Section "Construction Waste Management."

3.2 GENERAL

A. The existing Fire Alarm System, equipment, devices, and appliances shall remain in service until completion and acceptance of the new Fire Alarm Control Panel or be integrated with the new panel as follows:

1. As phasing of construction requires completion of a portion of the system, the existing fire alarm system components shall be interconnected with a new fire alarm system in such a way that initiation of either the existing or the new system (e.g., manual pull station, detection, etc.) shall sound a general alarm throughout the building for all existing notification appliances and all new notification appliances in the completed phase portion of the building.

2. Install new equipment, remove old, and perform acceptance test before proceeding to the next area. Provide a complete system at all times. At times this will require both the new and old systems to work in unison (e.g., tying the old system in as a part of the new system).

3. Removal of existing devices and circuits within areas of work is the responsibility of the contractor. The drawings do not show devices to be removed. The contractor shall remove all devices, wiring, and conduit as required as well as making temporary or permanent provisions for circuits to maintain the system as operational.

4. Coordinate covering of inactive pull boxes during construction. This would include existing pull stations that are inactive and yet to be demolished as well as new pull stations that are installed but not yet functional.

B. Provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations. All wiring shall be installed in strict accordance with all the provisions of the NEC. Upon completion, the contractor shall so certify in writing to the Owner and the Professional.

C. All associated conduit and wiring for wall-mounted appliances shall be hidden from view. Utilize recessed back boxes to mount the fire alarm device. As an example, this would include manual pull stations and alarm notification devices attached to gypsum or CMU walls. The contractor shall receive approval from the Owner, CM or Professional prior to routing any exposed raceway in finished areas of the building. The contractor shall coordinate the routing of the conduit and placement of boxes to meet this requirement.

D. All junction boxes shall be sprayed red and labeled "Fire Alarm". Wiring color code shall be maintained throughout the installation.

E. The contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of the installation. Detectors shall not be installed during construction. Installing detectors with a dust cover is not acceptable. Install detectors only after the building is clean and ready for testing and occupancy.

F. The NICET approved Distributor and Contractor supervising employees shall attend all meetings required by the Professional, Owner or CM. This shall include as a minimum a project kickoff meeting, monthly job site visits to supervise the installation, and final system acceptance.

G. Use of wire nuts is prohibited. Installing multiple wires on a single terminal is prohibited.

H. Provide a smoke detector over each Fire Alarm Control Unit. For the purpose of this project, the term Fire Alarm Control Unit shall apply to the FAP, Data Gathering Panels, and Notification Extender Panels.

I. Patching and repairing shall comply with Specification for cutting and patching. The removal of the existing fire alarm devices will create several typical patch and repair scenarios. The following is guidance to assist the contractor in understanding the extent of the work required. It is not intended that this portion of the specification be complete with regards to all patching that may be required.

1. Areas that are existing CMU, plaster or gypsum wallboard shall be patched to match the existing finish and painted in accordance with Specification 16060.

2. Areas that are of other existing material that would be difficult to match, shall have a cover plate slightly larger than the opening installed and painted to match the existing wall.

3. All existing holes shall be filled and patched to match the existing finish and painted in accordance with Specification 16060.

3.3 SYSTEM FIELD WIRING

A. Wire each signal line circuit and fire alarm indicating appliance circuit in accordance with manufacturer’s instructions. Provide fire alarm circuit conductors with color coded insulation, or use color coded tape at each conductor termination and in each junction box and interface panel.

B. Size and quantity of data, communication and control wiring along with related conduit where required shall be in accordance with the General Electrical Division Specifications, except as modified herein and the manufacturer’s recommendations and the referenced codes.

C. Signaling Line Circuits, Notification Appliance Circuits, and initiating device circuits shall be supervised in accordance with the requirements of NFPA 72 and the System Operation portion of this specification.

D. Provide wiring within cabinets installed parallel with or at right angles to the sides and back of the enclosure. All conductors which are terminated, spliced, or otherwise interrupted in any enclosure associated with the fire alarm system shall be connected with either crimp-on type connections or with crimp-on spade type connections to terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system.

E. Junction boxes with crimp-on type connections may be utilized where two (2) or fewer wiring connections are made. Provide a labeled terminal cabinet where more than two wiring connections are made.

F. For alarm and supervisory initiating device circuits and alarm indicating circuit wiring for the low voltage portion of the fire alarm system, provide all wiring as recommended by the equipment manufacturer. Provide wiring operating at 120 VAC as minimum No. 12 AWG solid copper having similar insulation.

G. Conduit:

1. Conductors shall be run in conduit in areas with exposed ceilings and unfinished areas throughout, except as otherwise noted. This portion of the system shall be installed in a manner approved by the National Electric Code and the AHJ utilizing approved raceways.

2. All conduit shall be rigid or EMT, sized at 3/4 inch minimum. The use of pre-finished, colored conduits, such as the Allied Tru Color EMT series, is preferred over painting of the pipe when the colors required are available (typically red, white, and black). The color shall be red in mechanical and utility space areas. Paint the conduit to match the ceiling or wall color in public accessible or other utilized areas as required and the prefinished conduits are not available in matching colors. Paint all intermediate junction boxes red. Boxes attached directly to a fire alarm device shall be painted the same color as the conduit. Any device wiring that is concealed in a wall or other similar space shall be provided with flexible metallic conduit, conduit or other suitable raceway. Label per specification 16195.

3. The use of Type MC fire alarm cable is permitted in lieu of conduit to the extent permitted by the NEC, except that conductors shall be in conduit or surface raceway as applicable in public or occupied areas with exposed ceilings. All Type MC fire alarm cable shall be red striped or otherwise identified. Type MC cable shall be similar to AFC Cable Systems Fire Alarm/Control Cable (product indicated to show level of quality and styling). Install, support and terminate as required by the NEC and the Manufacturer’s instructions.

H. Surface Raceway:

1. The building shall use exposed surface raceways as described in Section 3.1 above when it is necessary to route exposed cabling in public accessible areas. The extent to which surface raceway is permitted is based on the feasibility of first routing concealed conduit or fishing Type MC fire alarm cable to the device. Where this is not practical, surface raceway is permitted with the approval of the Owner, CM or Professional.

2. For any exposed surface raceways, metallic or non-metallic surface raceway is permissible. Non-metallic surface raceway shall be similar to Panduit LDP models (product indicated to show level of quality). All surface raceway shall be sized as required.

3. Provide new surface mounted back boxes to mount the fire alarm device in areas of the existing building where architectural work will not permit flush mounting and concealed conduit. Route new wiremold from above the ceilings, along architectural elements and down to devices where required.

4. Match or coordinate the surface raceway color with the adjoining surface to provide a uniform appearance. Paint as required and submit color samples to the Professional for approval.

I. Above Ceiling Wiring:

1. It is the intent of this Section to assure plenum rated cable installation is neat, well organized and without conflict with other components located above the ceiling area. The installation shall adhere to all the regulations set forth in the NFPA 72 and the NEC.

2. This section is an allowance for using exposed plenum rated cable and should not be constituted as a prohibition from using conduit or Type MC fire alarm cable at any location.

3. All exposed above ceiling wiring (not in conduit and not Type MC cable) shall be plenum rated cable. The cable shall be power-limited fire protective signaling circuit plenum cable, red in color, and distinctively marked, “FPLP”.

4. The cables shall be run through distinct bridle rings or J hooks which are to be properly affixed to the structure, wall and/or partition at maximum 5 foot intervals. Cables shall not rest on top of the suspended ceiling assembly nor shall they be bound to the side of threaded rod or ceiling support cables nor shall they be routed within general purpose or low voltage multi-use cable trays. Cables that run through the ceiling areas may be suspended directly from the structure or deck, but shall not be attached directly to equipment, pipes or ducts.

5. Where two (2) or more cables are run parallel to one another and are not within bridle rings, they shall be bound together by nylon tie straps at 5 foot intervals.

6. Plenum rated cable shall be run in conduit at all riser locations. Within areas where physical damage is anticipated, finish ceilings are not provided or when connecting to a wall mounted terminal device, conduit or Type MC fire alarm cable shall be utilized. All drops within walls shall be in a minimum of flexible metal conduit.

7. All drops to ceiling mounted devices shall be from a junction box mounted to the deck or structure. From this box, extend flexible metal conduit or ENT to the ceiling mounted device junction box. Wiring and conduit to ceiling mounted devices shall have adequate slack to allow for removal of the device or ceiling tile as necessary. For lay-in type acoustical ceiling tiles, the ceiling mounted junction box shall be attached to via a Caddy acoustical tee bar hanger or equivalent. The box shall not be directly attached to the ceiling tile.

8. All drops to wall mounted devices shall be in flexible metal conduit where the wire is fished or installed within the wall cavity.

9. All interfaces in and out of open ends of junction boxes or conduits shall be fitted with rubber grommets to minimize the potential for damage to the conductor insulation. Specific attention shall be made to hanging methods and the use of brushings or grommets at junction box outlets, stub-ups outlets or transitions to Type MC Cable.

10. Conduit “sleeves” shall be installed where wiring passes through any wall and/or partition.

11. Cables shall be run parallel to walls and/or partitions whenever possible.

12. The contractor shall review the installation techniques with the CM and Owner prior to beginning work and review any completed work after the first day of significant work. The contractor shall remove and replace any non approved installation at his own expense.

J. In accordance with NFPA 72, connections to the light and power service shall be on dedicated branch circuits. The circuits and connections shall be mechanically protected via a handle locking or similar device. Circuit disconnecting means shall have a red marking, shall be accessible only to authorized personnel, and shall be identified as FIRE ALARM CIRCUIT CONTROL. The location of the circuit disconnecting means shall be permanently identified at each fire alarm control unit. This shall apply to all fire alarm control, NAC, and similar panels.

K. Distinctively color code all wiring differently from the normal building wiring. Audible alarm indicating appliances shall be color coded differently from alarm initiating circuits. Use different colors for visible alarm indicating appliances.

L. Wiring connections shall be made by the Installing Contractor as shown on drawings furnished by the representative of the Distributor. Power shall not be applied to the system until the Distributor has approved the connections to the control equipment.

3.4 INSTALLATION OF FIRE ALARM INITIATING AND NOTIFICATION EQUIPMENT

A. All initiation and notification equipment shall be installed on back boxes/junction boxes. Field verify exact locations of all panels. All ceiling mounted devices in lay in ceiling areas shall utilize T-Bar hangers or approved equal. Provide a typed label on each manual pull station, detector, and interface module to indicate the loop and address number of the device.

B. Manual Pull Stations: Locate manual pull stations in areas shown on the drawings. Provide recessed back boxes in which the station operating mechanisms shall be mounted. Mount stations with the operating handles 42-inches above the finished floor.

C. Spot Type Smoke and Heat Detectors:

1. Locate detectors in areas shown on the drawings. Detectors located on the ceiling shall be installed not less than 4-inches from a side wall or to the near edge of a ceiling tile. The installation shall comply with the requirements of NFPA 72. Install smoke detectors no closer than 3 feet from HVAC registers.

2. The placement of smoke detectors provided for the closing of electromagnetic door holders shall comply with NFPA 72, except that detectors shall be placed on both sides of the door in all corridor or stairway applications. Area smoke detection may be used in lieu of additional detectors.

3. Verify the quantity and location of duct smoke detectors required with the HVAC schedules and drawings.

4. Devices in areas subject to damage, such as gymnasiums, shall be provided with a wire metal protective cover to protect the device from damage.

D. Audible/Visible Alarm Notification Appliances:

1. Locate alarm notification in areas shown on the drawings.

2. Wire audible appliances and visible appliances so they are not separately controlled as per NFPA 72.

3. As a minimum, zone each floor separately and synchronize all devices throughout the building.

4. Normal speaker circuits shall be designed to allow for each speaker to be tapped at 1 watt, except for those devices in high ambient noise level areas which should be designed to be tapped at 2 watts. Each speaker shall be tapped as required for the space being covered. Speakers shall be tapped at a minimum of ¼ watt.

5. Tap hard wall bathroom and small spaces at a 1/8 or ¼ watt tap. Corridors shall be set at ½ watt taps.

6. Speakers shall be tapped to achieve the best balance between audibility and intelligibility in each space. Contractor is responsible for adjusting wattage taps as required to achieve this balance.

7. System messages shall provide the pre-alert tone at the rated decibel level for the speaker at the specific wattage tap.

8. Devices in areas subject to damage, such as gymnasiums, shall be provided with a wire metal protective cover to protect the device from damage.

E. Visible Alarm Indicating Appliances:

1. Locate visible alarm indicating appliances in areas shown on the drawings. For wall mounted strobes, the strobe shall be installed such that the entire lens is not less than 80 inches and not more than 96 inches above the finished floor. Ceiling mounted devices shall be installed with the faceplate flush to the ceiling tile.

2. Provide spare capacity in circuits as described above. Strobe lights shall be wired for synchronized operation throughout.

3. Locate visible alarm indicating appliances in sleeping rooms (e.g., cot area for nurse) in accordance with NFPA 72.

4. Any areas that require alternate mounting locations must be coordinated with the Fire Alarm Distributor prior to submitting to the professional for approval. Adjust candela ratings and circuit calculations as required.

F. Fire Alarm Control Panel, Amplifier, and NAC Panels:

1. Locate the FAP where indicated on the drawings. The enclosure shall be recessed with top of the cabinet not more than 6 feet above the finished floor.

2. Locate NAC panels as required in approved locations. Panels may be located in storage rooms, janitor's closets, or other similar not normally occupied area. The Owner must approve these locations. The enclosures shall be surface mounted with the top of the cabinet not more than 6 feet above the finished floor.

3. Locate amplifiers adjacent to or integral with other fire alarm equipment panels. Bank or distribute amplifier panels throughout the building as required with the required backup capability.

4. Provide a smoke detector over the control panels in accordance with NFPA 72.

5. Provide typed quality labels on all panel identification cards.

6. Extend power from a dedicated spare 20 Amp, 1-Phase breaker in accordance with Part 1 of this Specification and the NEC. Field verify exact locations.

G. Remote FAA:

1. Locate all remote FAA units where indicated on the drawings. The enclosure shall be recessed with top of the cabinet not more than 5 feet above the finished floor.

2. The final location of each FAA unit shall be field verified and located such that it is visible upon entry into the building.

3. Wiring between the FAP and the FAA shall be electrically supervised.

H. Monitor and Control Modules:

1. Modules shall be mounted within 3 feet of the device being monitored or controlled. In public accessible areas, locate in the immediate vicinity of its associated component above the ceiling.

2. Modules shall be labeled with their respective addresses.

3. The Contractor is responsible for coordinating installation with the trade Contractor's providing the other devices.

4. The wiring between modules and their intended interface device, such as sprinkler system device, is solely the responsibility of the Fire Alarm Contractor.

5. Field verify the quantity and location of electromagnetic door holders and associated fire alarm interface (smoke detectors and control modules/relays) required. The Electrical Contractor shall connect these existing devices to the fire alarm system with the appropriate interface modules to release the doors on alarm. The Fire Alarm Contractor and Electrical Contractor shall work in a coordinated basis to test the units.

6. Verify the quantity and location of HVAC units requiring unit shutdown and associated fire alarm interface (smoke detectors and control modules/relays) required with the HVAC schedules and drawings.

I. The Contractor shall be responsible for coordination efforts with other construction trades working within the scope of this project.

3.5 MINIMUM SYSTEM TESTS

A. The Contractor and Distributor shall complete preliminary system testing prior to the Final testing to ensure that all systems are working properly.

B. The Contractor and Distributor shall develop a written testing plan and matrix to cover all aspects of system testing. As a minimum, this matrix should include areas for checking all devices and outputs. Output checking shall include representative samples of input devices from circuits or multiple circuits that contribute to multiple alarm outputs.

C. Notify the AHJ, Fire Marshal, Owner's Representative, CM, and the Professional in writing a minimum of 3 weeks prior to the Final acceptance test.

D. The completed fire alarm system shall be fully tested in accordance with the provisions of NFPA 72 by the contractor in the presence of the Professional, AHJ, Fire Marshal and the Owner. The Contractor and Distributor shall perform said tests as required by the Fire Marshal inspection personnel for the final test of equipment and operation of the system. An authorized representative from each supplier of equipment shall be in attendance at the testing to make necessary adjustments. The required tests are as follows:

1. Testing shall comply fully with NFPA 72.

2. Verify the absence of unwanted voltages between circuit conductors and ground. The tests shall be accomplished at the preliminary test with results available at the final system test.

3. Verify that the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.

4. Test and record each initiating device and indicating appliance and circuit for proper operation and response at the control unit, including those associated with all specified system interfaces. Testing of all system interfaces shall be conducted in cooperation with the respective system Contractors to verify that the systems function as specified in the Fire Alarm System Matrix of Operations.

5. Test and record the system for all specified functions in accordance with the contract drawings and specifications and the manufacturer's operating and maintenance manual.

6. Test both primary and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

7. Determine that the system is operable under trouble conditions as specified.

8. Visually inspect all wiring.

9. Test the battery charger and batteries. Mark the date of the test clearly and legibly directly on the batteries themselves.

10. Verify that all software control and data files have been entered or programmed into the FAP. Hard copy records of the software shall be provided to the Owner.

11. Verify that as-built drawings are accurate.

12. Measure and record the current in circuits to assure there is the specified spare capacity for the circuits.

13. Measure and record the voltage drop at the most remote appliance on each notification appliance circuit to assure that the voltage drop is not excessive.

14. Smoke detectors shall be tested for smoke entry (i.e., go/no-go tests (magnets) are not acceptable). Disconnect the verification feature for smoke detectors during tests to minimize the amount of smoke or test gas needed to activate the detector.

E. Audibility tests shall be performed to verify compliance with the requirements of the Americans with Disabilities Act Accessibility Guidelines (ADAAG). If the system does not meet the intended performance of the ADAAG, this contractor shall provide additional audible appliances and system expansion parts to accommodate them, as required to meet the required audibility levels.

F. The Distributor shall complete a 100 percent system inspection and test of all controls, devices, auxiliary operations and Supervising Station connections. The Distributor shall complete "Record of Completion" forms for the facility as described in NFPA 72, listing any deviations to the applicable codes and having a representative of the Fire Marshal sign the document. Copies of the completed Record of Completion shall be made available to any and all interested parties and be included in the Operation and Maintenance Manual provided to the Owner.

G. After Final testing is complete, provide a letter certifying that the installation is complete and fully operable to the Professional and the Owner. The letter shall include the names and titles of the witnesses to the preliminary tests and final acceptance tests.

H. Upon completion of a successful acceptance test, the contractor shall so certify in writing to the. AHJ.

3.6 TRAINING

A. Provide training session, minimum of two (2) at 1 hour each, for all personnel designated by the Owner. All training sessions shall be conducted prior to, or in conjunction with the testing of the system by an authorized representative of the fire alarm equipment distributor.

B. Training sessions shall cover all aspects of system performance, including system architecture, SLC configurations, sensor and other initiating device types, locations, device addresses, fire alarm control panel function key operation, the system Matrix of Operation, and other functions as designated by the Owner.

C. This training shall include training manuals, demonstration equipment and any other items required to assist the Owner in the operation and maintenance of the systems.

D. Comprehensive system troubleshooting training shall be provided for a single individual designated by Owner. This session shall be separate and distinct from the above described session and be a minimum of 2 hours.

3.7 SPARE PARTS AND TOOLS

A. All spare parts furnished shall be directly interchangeable with the corresponding components of the installed system. Spare parts shall be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts shall be delivered to the site in unopened cartons for storage in the building where directed.

B. Provide the following spare parts and accessories:

1. Spot type smoke detector, 1 of each type installed.

2. Heat detector, 1 of each type installed.

3. Manual Pull Station, 1 of each type required.

C. Furnish a list, in duplicate, of all other parts and accessories which the manufacturer of the system recommends to be stocked for maintenance.

3.8 KEYS

A. Keys and locks for all equipment shall be identical. Provide not less than 6 keys of each type required. Identify keys by an appropriate number stamped on each key or on a metal tag attached thereto. Provide a key numbering chart in each operation and maintenance manual.

3.9 WARRANTY

A. The Contractor shall warrant the fire alarm equipment and wiring to be free from inherent mechanical and electrical defects for a period of 1 year from the date of final installation and acceptance of the system by the Owner's representatives.

B. Within these warranties, all parts and the associated labor required for response, trouble shooting, repair and/or replacement are to be included.

C. The Owner requires an "8 hour maximum response time" for warranty related work. The Contractor shall be advised that this is a non-limited "8 hour maximum response time". Requirement shall cover any 24 hour period, 365 days per year during the warranty period.

3.10 SYSTEM SOFTWARE AND FIRMWARE

A. The contractor shall maintain record copies of all versions of system software installed. Changes in software shall be automatically identifiable when different versions of the system program are compared. Differences between the documents shall be distinctly highlighted to make it distinct from the normal program text.

B. The contractor shall maintain a record of all system firmware provided as part of the equipment. In addition, records shall be maintained of all firmware modifications from initial installation until final acceptance.

C. Provide the Owner with a written copy of all passwords or other access codes for the FAP.

D. Lack of documentation of software or firmware changes shall result in complete system re-acceptance testing.

E. Provide 2 programming changes as directed by the A/E, Owner, or Owner's Representative. This does not include programming changes required to make the system operation meet the contract document requirements and approval of the AHJ.

F. Upon completion of this project, the contractor shall turn over to the Owner the most current, virus-free copy of the downloadable, as-built fire alarm software. This information shall be in the following formats: Printed reproducible hard copy and Virus-Free Electronic Medial (flash drive or CD). In addition, any revisions created during the warranty period due to warranty related work shall also be issued to the Owner in the formats described at no additional cost.

END OF SECTION 28 31 00

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, removing site utilities and abandoning site utilities in place.
8. Temporary erosion and sedimentation control.

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 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 and according to requirements in Section 015639 "Temporary Tree and Plant Protection.".

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

1.5 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.6 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

B. Topsoil stripping and stockpiling program.

C. Rock stockpiling program.

D. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

E. Burning: Burning shall not be allowed.

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 traffic ways 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 the Owner’s Representative.

C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises as directed by the Owner’s Representative.

D. Utility Locator Service: Notify Miss Utility 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.

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. 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 Owner not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner's written permission.

D. Excavate for and remove underground utilities indicated to be removed.

E. 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 3 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods or air spade for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.
3. 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 construction area naturally formed rocks that measure more than 1 foot across in least dimension. Do not include excavated or crushed rock.

1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile rock away from edge of excavations without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.

1. Limit height of rock stockpiles to 36 inches.
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 a long 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. 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

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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 pavements.
6. Subbase course and base course for asphalt paving.
7. Subsurface drainage backfill for walls and trenches.
8. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Requirements:
1. Section 311000 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2. Section 312319 "Dewatering" for lowering and disposing of ground water during construction.
3. Section 315000 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
4. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
5. Section 329300 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, 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. for bulk excavation or 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-inchmaximum-width, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom.
2. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf 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. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM 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.

1.4 PREINSTALLATION MEETINGS

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

1. Review methods and procedures related to earthmoving, including, but not limited to, the following:

a. Personnel and equipment needed to make progress and avoid delays.
b. Coordination of Work with utility locator service.
c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
d. Extent of trenching by hand or with air spade.
e. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Controlled low-strength material, including design mixture.
3. Warning tapes.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Geotextile: 12 by 12 inches.
2. Warning Tape: 12 inches long; of each color.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 1557.

C. Blasting: Blasting shall not be allowed

D. 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.

1.7 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.8 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. 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 the Owner’s Representative.

C. Utility Locator Service: Notify "Miss Utility" 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 on the Drawings in Section 311000 "Site Clearing" 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. Onsite Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, SM and ML according to ASTM D 2487 or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Imported Soils: Shall have a Unified Soil Classifications of SM or better according to ASTM D 2487; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

D. Onsite Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, 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.

E. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.

I. Sand: ASTM C 33; fine aggregate.

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 ASTM D 4632.
    b. Sewn Seam Strength: 142 lbf ASTM D 4632.
    c. Tear Strength: 56 lbf; ASTM D 4533.
    d. Puncture Strength: 56 lbf; ASTM D 4833.

3. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
4. Permittivity: 0.2per 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 ; ASTM D 4632.
    b. Sewn Seam Strength: 222 lbf ; ASTM D 4632.
    c. Tear Strength: 90 lbf ; ASTM D 4533.
    d. Puncture Strength: 90 lbf ; ASTM D 4833.

3. Apparent Opening Size: No. 60 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, Type IIorType III.
2. Fly Ash: ASTM C 618, Class C or F.
3. Normal-Weight Aggregate: ASTM C 333/4-inch nominal maximum aggregate size.
4. Foaming Agent: ASTM C 869.
5. Water: ASTM C 94.
6. Air-Entraining Admixture: ASTM C 260.

B. Produce low-density, controlled low-strength material with the following physical properties:
1. Compressive Strength: 140 psi when tested according to ASTM C 495.

C. Produce conventional-weight, controlled low-strength material with 140-psi compressive strength when tested according to ASTM C 495.

2.4 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. 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.

3.4 EXCAVATION, GENERAL

A. 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 Owner's Representative. 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 outside of concrete forms other than at footings.
    b. 12 inches outside of concrete forms at footings.
    c. 6 inches outside of minimum required dimensions of concrete cast against grade.
    d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    e. 6 inches beneath bottom of concrete slabs-on-grade.
    f. 6 inches beneath pipe in trenches and the greater of [24 inches wider than pipe or 42 inches wide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: 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 in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches 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 deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trench Bottoms: Excavate trenches 6 inches 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 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 SUBGRADE INSPECTION

A. Notify Owner's Representative when excavations have reached required subgrade.

B. If Owner's Representative determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 20 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Owner's Representative .

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Owner's Representative.

3.10 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.

3.11 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.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

D. Trenches under Roadways: Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of subbase material or satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches 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 below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 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.

3.14 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.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 92 percent up to one foot below pavement section then compact final backfill at 97 percent.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch .
2. Walks: Plus or minus 1 inch .
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBSURFACE DRAINAGE

A. Subdrainage Pipe: Specified in Section 334600 "Subdrainage."

3.18 SUBBASE UNDER PAVEMENTS AND WALKS

A. Place subbase course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course under pavements and walks as follows:
1. Place base course material over subbase course under hot-mix asphalt pavement.
2. Shape subbase course to required crown elevations and cross-slope grades.
3. Place subbase course 6 inches or less in compacted thickness in a single layer.

4. Place subbase course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
5. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 97 percent of maximum dry unit weight according to ASTM D 1557.

C. Pavement Shoulders: Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders, at least 18 inches wide, of satisfactory soil materials and compact simultaneously with each subbase layer to not less than 97percent of maximum dry unit weight according to ASTM D 1557.

3.19 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.20 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. or less of paved area or building slab but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.

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.

3.21 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.

3.22 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 the Owner’s Representative.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 312319 - DEWATERING

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 construction dewatering.

B. Related Requirements:
   1. Section 312000 "Earth Moving" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.
   2. Section 334600 "Subdrainage" for permanent foundation wall, underfloor, and footing drainage.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

   1. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Review condition of site to be dewatered including coordination with temporary erosion-control measures and temporary controls and protections.
   3. Review geotechnical report.
   4. Review proposed site clearing and excavations.
   5. Review existing utilities and subsurface conditions.
   6. Review observation and monitoring of dewatering system.

1.4 ACTION SUBMITTALS

A. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified professional engineer.

   1. Include plans, elevations, sections, and details.
   2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
   3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.

4. Include written plan for dewatering operations including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and professional engineer.

B. Field quality-control reports.

C. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.

D. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in design of dewatering systems and dewatering work.

1.7 FIELD CONDITIONS

A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.
2. The geotechnical report is referenced elsewhere in Project Manual.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
3. Prevent surface water from entering excavations by grading, dikes, or other means.
4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
5. Remove dewatering system when no longer required for construction.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

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 dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Protect and maintain temporary erosion and sedimentation controls during dewatering operations.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.

2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.

C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
3. Maintain piezometric water level a minimum of 24 inches below bottom of excavation.

C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

3.4 FIELD QUALITY CONTROL

A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.

1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

B. Survey-Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

D. Prepare reports of observations.

3.5 PROTECTION

A. Protect and maintain dewatering system during dewatering operations.

B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 312319

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SECTION 316615 – DRILLED HELICAL PILES

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. Furnishing and installing drilled helical piles.
   2. Load testing.

B. Related Sections include the following:
   1. Division 01 Section "General Requirements."
   2. Division 01 Section "Special Procedures."
   3. Division 31 Section “Site Clearing”
   4. Division 31 Section “Trenching, Backfilling, and Compacting”
   5. Division 31 Section “Excavation and Fill”
   6. Division 03 Section "Cast-in-Place Concrete."
   7. Division 05 Section "Structural Steel".

1.3 SUBMITTALS

A. Submit under provisions of Division 01 Section "General Requirements."

B. Sustainable Design Submittals:
   1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Indicating the following:
   1. Number and location of helical piles on plan.
   2. Maximum allowable compression and tensile strength.
   3. Size and shape of Pile central shaft.
   4. Helix configuration, including size, shape, quantity, spacing of helixes.
   5. Depth / length of Pile, cut-off elevation.
   6. Connection of Piles to concrete Pile caps and grade beams.
   7. Installation details, including installation torque, and safety factor.

D. Design Calculations.
   1. This information shall be signed and sealed by a Professional Engineer currently licensed in the state of the Project.

E. Calibration reports of equipment used for installing helical Piles.

F. Proposed Load Testing Procedure.

G. Qualification Data: For qualified professional engineer, manufacturer, installer and testing agency.

H. Welding certificates.

I. Field quality-control reports: Driving record of each pile, including pile location, plumbness, blow count and welding.

J. Other Informational Submittals: Hammer data, including cap-block arrangement, weight and length of stroke of striking parts of hammer, number of operating blows per minute, piston area, and effective piston pressure.

1.4 QUALITY ASSURANCE

A. Codes and Standards:
1. AWS B2.1 “Standard for Welding Procedure and Performance Qualification”
2. ICC Evaluation Services AC358 Acceptance Criteria for Helical Foundation Systems and Devices
3. ASTM A123 Standard Specification for Zinc Coatings on Iron and Steel Products
4. ASTM A153 Standard Specification for Zinc Coatings on Iron and Steel Hardware
5. ASTM D1143 Method of Testing Piles Under Static Axial Compressive Load

B. Manufacturer Qualifications: A firm experienced in manufacturing helical Piles in accordance with the following:
1. Evidence showing manufacturer has at least 10 years in the design and manufacture of Helical Piles.
2. Current ICC-ES product evaluation report or complete description of product testing and engineering calculations used to assess product capacity.
3. Quality assurance program documentation showing methods used to assess and maintain product quality.

C. Installer Qualifications: An experienced installer that has specialized in helical Pile work similar to that indicated for this Project in material, design, and extent.

D. Testing Agency Qualifications: Qualified according to ASTM C 1077, ASTM D 3740, and ASTM E 329 for testing indicated.

E. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

F. 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 helical piles that are similar to those indicated for this Project in material, design, and extent.

G. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.5 PROJECT CONDITIONS

A. Existing Utilities: Locate existing underground utilities before excavating drilled Piles. If utilities are to remain in place, provide protection from damage during drilled-Pile operations.

1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.
2. Interruption of Existing Utilities: Do not interrupt any utility to facilities occupied by Owner or others unless arrangements have been made with Owner to provide temporary utilities.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner or Engineer will not be responsible for interpretations or conclusions drawn from this data.

C. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled Piles. Before excavating, lay out each drilled Pile to lines and levels required. Record actual measurements of each drilled Pile's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

1. Record and maintain information pertinent to each drilled Pile and cooperate with Owner's testing and inspecting agency to provide data for required reports.

PART 2 - PRODUCTS

2.1 GENERAL

A. It is the Contractor’s Pile Design Professional’s responsibility to select the appropriate size and type of helical pile to support the design loads shown on the Drawings. These specifications and the Drawings provide minimum requirements to aid the Contractor in making the appropriate material selections. The size and number of helical plates must be such that the helical piles achieve the appropriate torque and capacity in the soils within the minimum length requirements. Failure to achieve proper torque and capacity shall result in Contractor replacing helical piles as appropriate to support the required loads.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

2.2 PILE CENTRAL STEEL SHAFT

A. The central steel shaft may consist of one of the following, as required by the design loads.

1. Round-cornered square solid steel bars
2. Round-cornered square solid steel bars, high strength low alloy steel
3. Structural steel pipe
4. Structural steel tube

5. Combination of any of the above.

2.3 HELIX BEARING PLATES

A. The helix bearing plates shall be hot rolled carbon steel sheet, strip, or plate formed on matching metal dies to true helical shape and uniform pitch.

B. Material strength of the helix bearing plates shall be as required by the design loads, and shall be one of the following.
   1. ASTM A572, minimum yield strength of 50 ksi.
   2. ASTM A656, minimum yield strength of 80 ksi.
   3. ASTM A36, minimum yield strength of 36 ksi.

C. Corrosion Protection: Depending on the project requirements, helical piles shall be powder-coated or hot-dip galvanized.

2.4 MISCELLANEOUS

A. Bolts, of material specification and strength as required by the design loads, shall be used to connect the central steel shaft sections together.

B. Couplings

   1. For central steel shafts consisting of square solid steel bars, the couplings shall be formed as an integral part of the plain and helical extension material as hot upset forged sockets or as a cast steel sleeve with holes for connecting the shaft sections together.
   2. For steel tube, pipe, or combination central steel shafts, the couplings shall be formed as an integral part of the plain and helical extension material as hot forged expanded sockets or as internal sleeve wrought steel connectors of either tubing or solid steel bars with holes for connecting the shaft sections together.

C. Plates, Shapes

   1. ASTM A36, minimum yield strength of 36 ksi.
   2. ASTM A572, minimum yield strength of 50 ksi.

D. Pile Cap Connector

   1. The pile cap connector shall be a welded assembly consisting of structural steel plates and shapes designed to fit the Pile and transfer the applied load.

2.5 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Helical Piles:
      a. Magnum Piering, Inc.
      b. A B Chance

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by helical-Pile operations.

3.2 INSTALLATION EQUIPMENT

A. Installation equipment shall be rotary type, hydraulic power driven torque motor with clockwise and counter-clockwise rotation capabilities. The torque motor shall be capable of continuous adjustment to revolutions per minute (RPM's) during installation. Percussion drilling equipment shall not be permitted. The torque motor shall have torque capacity 15% greater than the torsional strength rating of the central steel shaft to be installed.

B. Equipment shall be capable of applying adequate down pressure and torque simultaneously to suit project conditions and load requirements. The equipment shall be capable of continuous position adjustment to maintain proper helical Pile alignment.

C. A torque indicator shall be used during helical Pile installation. The torque indicator can be an integral part of the installation equipment or externally mounted in-line with the installation tooling.

1. The torque indicator shall be capable of providing continuous measurement of applied torque throughout the installation.
2. The torque indicator shall be capable of torque measurements in increments of at least 500 ft-lb.
3. The torque indicator shall be calibrated prior to start of work. Torque indicators which are an integral part of the installation equipment shall be calibrated on site. Torque indicators which are mounted in line with the installation tooling shall be calibrated either on site or at an appropriately equipped test facility. Indicators that measure torque as a function of hydraulic pressure shall be calibrated at normal operating temperatures.

3.3 INSTALLATION PROCEDURES

A. Central steel shaft

1. The helical Pile installation technique shall be such that it is consistent with the geotechnical, logistical, and load-carrying conditions of the project.
2. The lead section shall be positioned at the location as shown on the drawings. The helical Pile sections shall be engaged and advanced into the soil in a smooth, continuous manner at a rate of rotation of 5 to 20 RPM's. Extension sections shall be provided to obtain the required minimum overall length and installation torque required. Connect sections together using coupling bolt(s) and nut(s) torqued to 40 ft lb.
3. Sufficient down pressure shall be applied to uniformly advance the helical Pile sections approximately 3 inches per revolution. The rate of rotation and magnitude of down pressure shall be adjusted for different soil conditions and depths.

B. Termination Procedures

1. The torque as measured during the installation shall not exceed the torsional strength rating of the central steel shaft.
2. The minimum installation torque and minimum overall length criteria required shall be satisfied prior to terminating the helical Pile installation.
3. If the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to achieving the minimum overall length required, the Contractor shall:

    a. Terminate the installation at the depth obtained subject to review and acceptance of the Owner or Engineer.
    b. Remove the existing helical Pile and install a new one with fewer and/or smaller diameter helix plates. The new helix configuration shall be subject to review and acceptance of the Owner or Engineer. If re-installing in the same location, the top most helix of the new helical Pile shall be terminated at least three feet beyond the terminating depth of the original helical Pile.

4. If the minimum installation torque as required is not achieved at the minimum overall length, the Contractor shall:

    a. Install the helical Pile using additional extension sections.
    b. Remove the existing helical Pile and install a new one with additional and/or larger diameter helix plates. The new helix configuration shall be subject to review by the Owner or Engineer. If re-installing in the same location, the top-most helix of the new helical Pile shall be terminated at least three feet beyond the terminating depth of the original helical Pile.
    c. De-rate the capacity of the helical Pile and install additional helical Pile(s). The de-rated capacity and additional helical Pile location shall be subject to review and acceptance by the Owner or Engineer.

5. If the helical Pile is refused or deflected by a subsurface obstruction, the installation shall be terminated and the Pile removed. The obstruction shall be removed, if feasible, and the helical Pile re-installed. If the obstruction cannot be removed, the helical Pile shall be installed at an adjacent location, subject to review and acceptance by the Owner or Engineer.
6. If the torsional strength rating of the central steel shaft and/or installation equipment had been reached prior to proper positioning of the last plain extension section relative to the final elevation, the Contractor may remove the last plain extension and replace it with a shorter length extension. If it's not feasible to remove the last plain extension, the Contractor may cut said extension shaft to the correct elevation. The Contractor shall not reverse the helical Pile to facilitate extension removal.
7. The average torque for the last three feet of penetration shall be used as the basis of comparison with the minimum installation torque as required. The average torque shall be defined as the average of the last three readings recorded at one foot intervals.

3.4 LOAD TESTS

A. Equipment

1. The load test equipment shall be capable of increasing or decreasing the applied load incrementally. The incremental control shall allow for small adjustments, which may be necessary to maintain the applied load for a sustained hold period.

2. The reaction system shall be designed so as to have sufficient strength and capacity to distribute the test loads to the ground. It should also be designed to minimize its movement under load and to prevent applying an eccentric load to the pile head. Test loads are normally higher than the design loads of the structure. The direction of the applied load shall be co-linear with the helical Pile at all times.
3. Dial gauges shall be used to measure helical Pile movement. The dial gauge shall have an accuracy of at least +/- 0.001 inch and a minimum travel sufficient to measure all helical Pile movement without requiring resetting the gauge. The dial gauge shall be positioned so its stem is parallel with the axis of the helical Pile. The stem may rest on a smooth plate located at the pile head. Said plate shall be positioned perpendicular to the axis of the helical Pile. The dial gauge shall be supported by a reference apparatus to provide an independent fixed reference point. Said reference apparatus shall be independent of the reaction system and shall not be affected by any movement of the reaction system.

B. Testing Program

1. The hydraulic jack shall be positioned at the beginning of the test such that the unloading and repositioning of the jack during the test shall not be required. The jack shall also be positioned co-axial with respect to the pile-head so as to not minimize eccentric loading. The hydraulic jack shall be capable of applying a load not less than two times the proposed design load. The pressure gauge shall be graduated in 100 psi increments or less. The stroke of the jack shall not be less than the theoretical shortening of the total helical Pile length at the maximum test load.
2. An alignment load shall be applied to the helical Pile prior to setting the deflection measuring equipment to zero or a reference position. The alignment load shall be no more than 10% of the design load. After the alignment load is applied, the test set-up shall be inspected carefully to ensure it is safe to proceed.
3. Axial compression or tension load tests shall be conducted by loading the helical Pile in stepwise fashion to the extent practical. Pile-head deflection shall be recorded at the beginning of each step and after the end of the hold time. The beginning of the hold time shall be defined as the moment when the load equipment achieves the required load step.
4. Test loads shall be applied until continuous jacking is required to maintain the load step or until the test load increment equals 200% of the design load, whichever occurs first. The observation period for this last load increment shall be 10 minutes.
5. The applied test load shall be removed in four approximately equal increments. The hold time for these increments shall be 1 minute, except for the last, which shall be held for 5 minutes.

C. Acceptance Criteria

1. The helical Pile shall sustain the compression and tension design capacities with no more than 1 inch vertical movement of the pile-head or as recommended by the geotechnical engineering report, as measured relative to the top of the helical Pile prior to the start of testing.
2. Failure does not occur at the 200% of the design load maximum compression and tension test loads. Failure load is considered to be one of the following, whichever results in the lesser load.
    a. The point in which the movement of the helical Pile tip exceeds the elastic compression/tension of the pile shaft by 0.08 times the diameter of the largest helix.
    b. The point at which the slope of the load versus deflection (at the end of increment) curve exceeds 0.05 inches/kip.

3.5 FIELD QUALITY CONTROL

A. The Contractor shall submit for review and acceptance the proposed Helical pile load testing procedure in accordance with ASTM D1143and/or ASTM D3689.

B. The Contractor shall provide the Owner and Engineer with copies of the field test reports confirming helical Pile configuration and construction details within 24 hours after completion of the load tests. The written documentation shall either confirm the load capacity as required or propose changes based on the results.

C. Pre-Production Tests: Load tests shall be performed to verify the suitability and capacity of the proposed Helical Pile, and the proposed installation procedures prior to the installation of production helical piles. At least one sacrificial test helical pile shall be constructed immediately prior to start of work on the production piles. Pre-production Helical pile installation methods, procedures, equipment, and overall length shall be identical to the production helical piles to the extent practical.

D. Production Pile Testing: The Contractor shall perform load tests on a minimum of 10% of the total production helical Piles. The locations of the Helical Piles to be tested shall be determined by the Contractor. If one of the Piles fails the load test, an adjacent Pile shall be tested. If the adjacent Pile fails to meet the acceptance criteria also, modifications shall be made to the Pile.

E. When a helical Pile fails to meet the acceptance criteria, modifications shall be made to the design, the construction procedures, or both. These modifications include, but are not limited to, de-rating the helical Pile capacity, modifying the installation methods and equipment, increasing the minimum effective installation torque, changing the helix configuration, or changing the helical per material. Modifications that require changes to the structure shall have prior review and acceptance by the Owner or Engineer.

END OF SECTION 316615

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.

B. City of Baltimore Specifications for Materials, Highways, Bridges, Utilities and Incidental Structures, latest edition.

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.

B. Related Requirements:

1. Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition" for demolition and removal of existing asphalt pavement.
2. Section 312000 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
3. Section 321373 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.
4. Section 321400 "Unit Paving" for bituminous setting bed for pavers.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.4 ACTION SUBMITTALS

A. Product Data: 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.

B. Sustainable Design Submittals:

1. For products having recycled content, submit documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

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 Maryland Department of Transportation State Highway Administration.

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 the City of Baltimore Specifications for Materials, Highways, Bridges, Utilities, and Incidental Structures (City of Baltimore Specifications), latest edition, for asphalt paving work.

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.
2. Tack Coat: Minimum surface temperature of 60 deg F.
3. Asphalt Base Course: Minimum surface temperature of 32 deg F and rising at time of placement.
4. Asphalt Surface Course: Minimum surface temperature of 40 deg F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D 242], rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320, PG 64-22.

B. Emulsified Asphalt Prime Coat: AASHTO M 140 emulsified asphalt, or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

C. Tack Coat: AASHTO M 140 emulsified asphalt, or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

D. Water: Potable.

E. Undersealing Asphalt: ASTM D 3141; 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 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 6690Type I, Type II and III, hot-applied, single-component, polymer-modified bituminous sealant.

2.4 MIXES

A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Provide mixes conforming to the City of Baltimore Specifications, Latest Edition and/or the Maryland Department of Transportation State Highway Administration Specifications.
2. Base Course: Superpave Asphalt Mix Design, HMA Base Course 19MM Mix, PG 64S-22, Level 2.
3. Surface Course: Superpave Asphalt Mix Design, HMA Wearing 9.5 MM Mix, PG 64S-22, Level 2.

B. Emulsified-Asphalt Slurry: AASHTO M140 or M208 in accordance with the City of Baltimore Specifications, Latest Edition and/or the Maryland Department of Transportation State Highway Administration Specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 20 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Owner’s representative, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of 2 inches.

2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Patch surface depressions deeper than 1 inch after milling, before wearing course is laid.
7. Keep milled pavement surface free of loose material and dust.
8. Do not allow milled materials to accumulate on-site.

3.3 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd. .

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing 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.

3.4 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.

2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch 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 wide. Fill flush with surface of existing pavement and remove excess.

3.5 SURFACE PREPARATION

A. General: 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. 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. 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. Tack Coat: Apply uniformly to surfaces of existing pavement by full circulation spray bars that are laterally and vertically adjustable and provide triple fanning and overlapping action at a rate sufficient to result in a coating with residual asphalt applied at a rate of 0.01 to 0.05 gal./sq.yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.6 PAVING GEOTEXTILE INSTALLATION

A. Apply tack coat uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd..

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 and transverse joints 6 inches.

C. Protect paving geotextile from traffic and other damage, and place hot-mix asphalt overlay the same day.

3.7 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.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
2. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.8 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method 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.

3.9 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927, 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, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.10 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.

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, 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.

    a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than three cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION 321216

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SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes Concrete Paving including the following:

1. Driveways.
2. Roadways.
3. Parking lots.
4. Curbs and gutters.
5. Sidewalks.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
2. 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.
3. Section 321713 "Parking Bumpers."
4. Section 321723 "Pavement Markings."
5. Section 321726 "Tactile Warning Surfacing" for detectable warning pavers.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

a. Concrete mixture design.
b. Quality control of concrete materials and concrete paving construction practices.

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

    a. Contractor's superintendent.
    b. Independent testing agency responsible for concrete design mixtures.
    c. Ready-mix concrete manufacturer.
    d. Concrete paving Subcontractor.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. 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. Laboratory Test Reports: For concrete paving mixtures, documentation indicating that cured concrete complies with Solar Reflectance Index requirements.

C. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Curing compounds.
5. Bonding agent or epoxy adhesive.
6. 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 94requirements 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.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.9 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064, fabricated from galvanized-steel wire into flat sheets.

C. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064, flat sheet.

D. Epoxy-Coated Welded-Wire Reinforcement: ASTM A 884, Class A, plain steel.

E. Reinforcing Bars: ASTM A 615, Grade 60; deformed.

F. Epoxy-Coated Reinforcing Bars: ASTM A 775 or ASTM A 934; with ASTM A 615, Grade 60 deformed bars.

G. Steel Bar Mats: ASTM A 184; with ASTM A 615, Grade 60 deformed bars; assembled with clips.

H. Plain-Steel Wire: ASTM A 1064, galvanized.

I. Deformed-Steel Wire: ASTM A 1064.

J. Epoxy-Coated-Steel Wire: ASTM A 884, Class A; coated, deformed.

K. Epoxy-Coated, Joint Dowel Bars: ASTM A 775; with ASTM A 615, Grade 60 plain-steel bars.

L. Tie Bars: ASTM A 615, Grade 60 deformed.

M. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

N. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

O. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

P. Zinc Repair Material: ASTM A 780.

2.4 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within 500 miles of Project site from aggregates and cementitious materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, gray portland cement Type II.
2. Fly Ash: ASTM C 618, Class C or Class F.
3. Slag Cement: ASTM C 989, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C 595 Type IP, portland-pozzolan cement.

C. Normal-Weight Aggregates: ASTM C 33, Class 4S or Class 4M , uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials. Coarse and fine aggregate shall not contain more than one percent contaminants by weight.

1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain no more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494, Type A.
2. Retarding Admixture: ASTM C 494, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.

F. Water: Potable and complying with ASTM C 94.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 10 oz./sq. yd. dry or 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.
   a. Euclid Chemical Company (The), an RPM company; Eucobar.
   b. L&M Construction Chemicals, Inc.; E-CON.
   c. Sika Corporation, Inc.; SikaFilm.
   d. Or approved equal.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
   a. Euclid Chemical Company (The), an RPM company; Kurez W VOX.
   b. L&M Construction Chemicals, Inc.; L&M CURE R.
   c. Euclid Chemical Company (The); TAMMSCURE WB 30C.
   d. Or approved equal.

F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.
   a. Euclid Chemical Company (The), an RPM company; Kurez VOX White Pigmented.
   b. L&M Construction Chemicals, Inc.; L&M CURE R-2.
   c. W. R. meadows, Inc.; 1100-WHITE SERIES.
   d. Or approved equal.

2.6 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, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy-Bonding Adhesive: ASTM C 881, 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 I and II, for nonload bearing and Types IV and V, for 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
   a. Euclid Chemical Company (The), an RPM company; Surface Retarder Formula S.
   b. W. R. Meadows Inc.; TOP-STOP.
   c. Sika Corporation, Inc.; Rugasol-S.
   d. Or approved equal,

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

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: 6-1/2 percent plus or minus 1-1/2 percent for 1-1/2-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture, high-range, water-reducing admixture, plasticizing 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. Concrete Mix No. 2.

1. Compressive Strength (28 Days): 3000 psi.
2. Maximum W/C Ratio at Point of Placement: 0.50.
3. Slump Range: 2 to 5 inches.
4. Solar Reflectance Index: Not less than 29.

G. Concrete Mix No. 7.

1. Compressive Strength (28 Days): 4200 psi.
2. Maximum W/C Ratio at Point of Placement: 0.50.
3. Slump Range: 1-1/2 to 3 inches, 2-1/2 inch maximum if slip-formed.
4. Solar Reflectance Index: Not less than 29.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94 and ASTM C 1116. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd. .
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 20 tons.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 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.

G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

    a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

    a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. 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 deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 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, no minus.

3.9 CONCRETE PROTECTION AND CURING

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

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing curing compound or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches , and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch .
2. Thickness: Plus 3/8 inch , minus 1/4 inch.
3. Surface: Gap below 10-feet- long; unleveled straightedge not to exceed 1/2 inch .
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch
6. Vertical Alignment of Dowels: 1/4 inch
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.

9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.11 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 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 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; 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, 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; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to the Owner’s Representative, 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 the Owner’s Representative 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 the Owner's Representative.

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.

3.12 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 the Owner's Representative.

B. Drill test cores, where directed by the Owner's Representative, 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

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SECTION 321373 - 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.
2. Hot-applied joint sealants.
3. Joint-sealant backer materials.
4. Primers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Product Certificates: For each type of joint sealant and accessory.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.

1.6 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.

3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

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.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D 5893, Type NS.

a. Crafco Inc.; RoadSaver Silicone.
b. Dow Corning Corporation; 888.
c. Pecora Corporation; 301 NS.
d. Or approved equal.

B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D 5893, Type SL.

a. Crafco Inc.; RoadSaver Silicone SL.
b. Dow Corning Corporation; 890-SL.
c. Pecora Corporation; 300 SL.
d. Or approved equal.

2.3 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I, II, or III.

a. Crafco Inc.; RoadSaver 222.
b. Meadows, W.R., Inc.; Sealtight 3405.
c. Right Pointe; JTS 3405 Regular 003 or JTS 3405 Rubber 009.
d. Or approved equal.

2.

2.4 JOINT-SEALANT BACKER MATERIALS

A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM 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.

2.5 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backings 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 immediately following backing installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants 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 AND PROTECTION

A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.5 PAVING-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within concrete paving.

1. Joint Location:

   a. Expansion and isolation joints in concrete paving.
   b. Contraction joints in concrete paving.
   c. Other joints as indicated.

2. Joint Sealant: Single-component, nonsag, silicone joint sealant or Single-component, self-leveling, silicone joint sealant.
3. Joint-Sealant Color: Manufacturer's standard.

B. Joint-Sealant Application: Joints within concrete paving and between concrete and asphalt paving.

1. Joint Location:

   a. Joints between concrete and asphalt paving.
   b. Joints between concrete curbs and asphalt paving.
   c. Other joints as indicated.

2. Joint Sealant: Hot-applied, single-component joint sealant.
3. Joint-Sealant Color: Manufacturer's standard.

END OF SECTION 321373

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SECTION 321713 - PARKING BUMPERS

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 wheelstops.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PARKING BUMPERS

A. Concrete wheelstops: Precast, steel-reinforced, air-entrained concrete, 4000-psi minimum compressive strength, dimensions as indicated on the Drawings. Provide chamfered corners, transverse drainage slots on underside, and a minimum of two factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.

1. Surface Appearance: Free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.
2. Mounting Hardware: Galvanized-steel spike or dowel**,** #4 Bars, 24-inch minimum length.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install wheelstops according to manufacturer's written instructions unless otherwise indicated.

B. Install wheelstops in bed of adhesive before anchoring.

C. Securely anchor wheelstops to pavement with hardware in each preformed vertical hole in wheelstop as recommended in writing by manufacturer. Recess head of hardware beneath top of wheelstop.

END OF SECTION 321713

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.

1.3 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site

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.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the Maryland Department of Transportation State Highway Administration Standard Specifications for Construction and Materials Book, Latest Edition for pavement-marking work.

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 and not exceeding 95 deg F

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. As approved by the Maryland Department of Transportation State Highway Administration and listed in their List of Qualified Producers and Products for Pavement Marking Materials, Latest Edition.

2.2 PAVEMENT-MARKING PAINT

A. 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 45 minutes.

1. Color: As indicated on the Drawings.

B. Glass Beads: AASHTO M 247, Maryland Blend Gradation as specified in the Maryland Department of Transportation State Highway Administration Standard Specifications for Construction and Materials, Latest Edition.

1. Roundness: Minimum 75 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 Owner’s Representative.

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 18 ± 1 mils.

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 the stencil. Apply paint so that it cannot run beneath the stencil.
2. Broadcast glass beads uniformly into wet markings at a rate of 7 to 9 lb/gal.

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

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SECTION 321726 - TACTILE WARNING SURFACING

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. Detectable warning unit pavers.

B. Related Requirements:

   1. Section 321313 "Concrete Paving" for concrete walkways serving as substrates for tactile warning surfacing.
   2. Section 321400 "Unit Paving" for unit paving installations incorporating detectable warning unit pavers specified in this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 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.

B. Weather Limitations for Adhesive Application:

   1. Apply adhesive only when ambient temperature is above 50 deg F and when temperature has not been below 35 deg F for 12 hours immediately before application. Do not apply when substrate is wet or contains excess moisture.

C. Weather Limitations for Mortar and Grout:

   1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
   2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks, and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.

a. When ambient temperature exceeds 100 deg F or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F set unit pavers within 1 minute of spreading setting-bed mortar.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of tactile warning surfaces that fail in materials or workmanship within warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering and wear.

PART 2 - PRODUCTS

2.1 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities for tactile warning surfaces.

1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

B. Source Limitations: Obtain each type of tactile warning surfacing, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 DETECTABLE WARNING UNIT PAVERS

A. Detectable Warning Concrete Unit Pavers: Solid paving units, made from normal-weight concrete with a compressive strength of not less than 5000 psi, water absorption of not more than 5 percent according to ASTM C 140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67, with accessible detectable warning truncated domes on exposed surface of units.

1. Shapes and Sizes: As indicated on the Drawings.
2. Dome Spacing and Configuration: As indicated on the Drawings.
3. Color: As indicated on the Drawings.

B. Setting Bed: Comply with requirements in Section 321400 "Unit Paving."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions. Verify that installation of tactile warning surfacing will comply with accessibility requirements upon completion.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TACTILE WARNING SURFACING

A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.

3.3 INSTALLATION OF DETECTABLE WARNING UNIT PAVERS

A. Unit Paver Installation, General:

1. Setting-Bed and Unit Paver Installation: Comply with installation requirements in Section 321400 "Unit Paving."
2. Mix unit pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
3. Cut unit pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.
4. Tolerances: Do not exceed 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.

3.4 CLEANING AND PROTECTION

A. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Owner’s Representative. Replace using tactile warning surfacing installation methods acceptable to Owner’s Representative.

B. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION 321726

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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. Identification devices.
4. Grout.
5. Flowable fill.
6. Piped utility demolition.
7. Piping system common requirements.
8. Equipment installation common requirements.
9. Painting.
10. Concrete bases.

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. PE: Polyethylene plastic.

D. PVC: Polyvinylchloride Plastic.

1.4 SUBMITTALS

A. Product Data: For the following:
1. Identification devices.

1.5 QUALITY ASSURANCE

A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.6 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.

1.7 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.

PART 2 - PRODUCTS

2.1 TRANSITION FITTINGS

A. AWWA Transition Couplings NPS 2 (DN 50) and Larger:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cascade Waterworks Mfg. Co.
b. Dresser, Inc.; DMD Div.
c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
d. JCM Industries.
e. Smith-Blair, Inc.
f. Viking Johnson.

2.2 SLEEVES

A. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

B. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.3 IDENTIFICATION DEVICES

A. General: Products specified are for applications referenced in other Division 33 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 for ducts, and 3/4 inch for access door signs and similar operational instructions.

1. Material: Fiberboard.
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. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.

E. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.

F. 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.

G. Lettering: Manufacturer's standard preprinted captions as selected by Architect.

H. 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.

I. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils thick.

1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
2. Color: Comply with ASME A13.1, unless otherwise indicated.

J. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.

1. Material: 0.032-inch- thick, polished brass.
2. Material: 0.0375-inch- thick stainless steel.

3. Material: 3/32-inch- thick plastic laminate with 2 black surfaces and a white inner layer.
4. Size: 1-1/2 inches in diameter, unless otherwise indicated.

K. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.

L. 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, unless otherwise indicated.
3. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.

M. 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 for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

N. 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.

2.4 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, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.5 FLOWABLE FILL

A. Description: Low-strength-concrete, flowable-slurry mix.

1. Cement: ASTM C 150, Type I, portland.
2. Aggregates: ASTM C 33, natural sand, fine.
3. Admixture: ASTM C 618, fly-ash mineral.
4. Water: Comply with ASTM C 94/C 94M.
5. Strength: 200 psig at 28 days.

PART 3 - EXECUTION

3.1 PIPED UTILITY DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure 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 PIPING INSTALLATION

A. Install piping according to the following requirements and Division 33 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. 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 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.

J. Verify final equipment locations for roughing-in.

K. Refer to equipment specifications in other Sections for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 33 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. 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. PVC Nonpressure Piping: Join according to ASTM D 2855.

H. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

I. 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.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.5 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.

3.6 PAINTING

A. Painting of piped utility systems, equipment, and components is specified in Division 09 painting Sections.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 IDENTIFICATION

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
   1. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
   2. 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 high for name of unit if viewing distance is less than 24 inches, 1/2 inch high for distances up to 72 inches, 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.

3.8 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 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 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 Division 03 Section " Miscellaneous Cast-in-Place Concrete"

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "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.

3.10 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

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SECTION 334100 - STORM UTILITY 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.

B. City of Baltimore Specifications for Materials, Highways, Bridges, Utilities and Incidental Structures, latest edition.

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Nonpressure transition couplings.
3. Cleanouts.
4. Drains.
5. Encasement for piping.
6. Manholes.
7. Channel drainage systems.
8. Catch basins.
9. Stormwater inlets.
10. Pipe outlets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Catch basins, stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.

1.4 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.

D. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Construction Manager's and Owner's written permission.

PART 2 - PRODUCTS

2.1 PE PIPE AND FITTINGS

A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10 : AASHTO M 252, Type S, with smooth waterway for coupling joints.
1. Soiltight Couplings: AASHTO M 252, corrugated, matching tube and fittings.

B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294, Type S, with smooth waterway for coupling joints.
1. Soiltight Couplings: AASHTO M 294, corrugated, matching pipe and fittings.

2.2 PVC PIPE AND FITTINGS

A. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D 3034, SDR 35, 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.

2.3 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.

1. Bell-and-spigot ends and gasketed joints with ASTM C 443, rubber gaskets
2. Class IV

2.4 CLEANOUTS

A. Plastic Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.5 MANHOLES

A. Standard Precast Concrete Manholes:

1. City of Baltimore Standard Detail for 48-inch precast storm manhole for 15- to 24-inch pipes as indicated on the Drawings and in accordance with The City of Baltimore Specifications for Materials, Highways, Bridges, Utilities and Incidental Structures, latest edition.
2. Pipe Connections: inlets and outlet pipes shall be set or cut flush with the inside faces of the structures and shall extend a sufficient distance beyond the outside faces of the wall to provide room for proper connections. The joint around the pipe in the structure wall shall be completely and neatly closed with mortar or other approved material.

B. Manhole Frames and Covers:

1. City of Baltimore Standard Detail for 30-inch Storm Drain Manhole Cover and Frame as indicated on the Drawings.

2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Types and Sizes as indicated on the plans and according to City of Baltimore Specifications for Materials, Highways, Bridges, Utilities and Incidental Structures and the City of Baltimore Standards Details.

    a. Invert Slope: 2 percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

a. Slope: 1 inch per foot.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.50 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615, Grade 60 deformed steel.

2.7 DRAIN BASINS

A. PVC Drain Basins: shall be manufactured from PVC pipe stock, utilizing a thermoforming process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The flexible elastomeric seals shall conform to ASTM F477. The pipe bell spigot shall be joined to the main body of the drain basin or catch basin. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs of the surface drainage inlets shall conform to ASTM D1784 cell class 12454.

B. Grates: The ductile iron grates for each of these fittings are to be considered an integral part of the surface drainage inlet and shall be furnished by the same manufacturer.

1. 12”, 15” and 18” square grates will be hinged to the frame using pins. Ductile iron used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05. Grates and covers shall be provided painted black.
2. H-10 Load Rating.

2.8 STORMWATER INLETS

A. Inlets: Types and Sizes as indicated on the plans and according to City of Baltimore Standard Detail and the City of Baltimore Specifications for Materials, Highways, Bridges, Utilities and Incidental Structures, latest edition.

B. Frames and Grates: Types and Sizes as indicated on the plans and according to City of Baltimore Standard Detail and the City of Baltimore Specifications for Materials, Highways, Bridges, Utilities and Incidental Structures, latest edition.

2.9 PIPE OUTLETS

A. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to the 2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control, Section H, table H.2.

1. Riprap Class: As indicated on the plan

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, non-pressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
3. Install piping at depth and cover as indicated on the plans.
4. Install PE corrugated sewer piping according to ASTM D 2321.
5. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:
1. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
2. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
   1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot traffic areas.
   2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
   3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
   4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.
   5. Set cleanout frames and covers in earth with tops 1 inch above surrounding earth grade.

B. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 DRAIN INSTALLATION

A. The PVC surface drainage inlets shall be installed using conventional flexible pipe backfill.

B. Materials and procedures. The backfill material shall be crushed stone or other granular requirements of Class 2 material as defined by ASTM D2321. Bedding and backfill for surface drainage inlets shall be placed and compacted uniformly in accordance with ASTM D2321. The drain basin body will be cut at the time that final grade is established. No brick, stone, or concrete block will be required to set the grate at the final grade height. For other installation considerations such as migration of fines, ground water, and soft foundations, refer to ASTM D2321 guidelines.

3.6 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Manhole sections manufactured according to ASTM C-478 and AASHTO M199. The joints shall be sealed by the Contractor and made watertight using O-Ring rubber gasket and profile joints meeting ASTM C-443 and C-361. Flexible plastic gasket to meet AASHTO M198 Type B.

C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.7 STORMWATER INLET AND OUTLET INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Install according to City of Baltimore Standard Detail and the City of Baltimore Specifications for Materials, Highways, Bridges, Utilities and Incidental Structures, latest edition.

C. Set tops of frames and covers flush with finished surface of inlets that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.8 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.9 CONNECTIONS

A. Connect non-pressure, gravity-flow drainage piping in building's storm building drains specified in Section 221413 "Facility Storm Drainage Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.10 CLOSING ABANDONED STORM DRAINAGE 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 thick, brick masonry bulkheads.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and as specified below:

1. Remove manhole or structure and close open ends of remaining piping.

C. Backfill to grade according to Section 312000 "Earth Moving."

3.11 IDENTIFICATION

A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.12 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems 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. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

a. Exception: Piping with soil tight joints unless required by authorities having jurisdiction.
b. Option: Test plastic piping according to ASTM F 1417.
c. Option: Test concrete piping according to ASTM C 924.

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.

3.13 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

END OF SECTION 334100

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